THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 30. Thursday, August 14, 1924. No. 417.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
"Body" and Liquidity	127
Correspondence	128, 139
Complimentary Dinner to Mr. Cole Estep	129
German Foundrymen's Association	129
Patent Specifications	129
Book Review	129
Mayari Pig-Iron	130
Modern Methods of Pipe Manufacture by the Centrifugal Process	131
Discussion upon Mr. O. Smalley's Paper on "The Cylinder Problem"	140
Life of Cast-Iron Chill Moulds	142
Is the Lanz Method Essential to the Production of Pearlitic Cast Iron?	143
Silica Brick of Constant Size	144
A Note on Files	144
Trade Talk	146
Contracts Open	146
Company News	146
Personal	146
Iron and Steel Markets	148

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE
INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

Institute of British Foundrymen.

PRESIDENT, 1924-25, R. O. Patterson, Blaydon-on-Tyne.

LIST OF SECRETARIES—

General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.

Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.

Birmingham: H. James Roe, 33, Herbert Road, Bearwood, Birmingham.

Sheffield: R. Village, Albion Foundry, Whittington Moor, near Chesterfield.

Scottish: J. Bell, 60, St. Enoch Square, Glasgow.

London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.

Newcastle-on-Tyne: Colin Gresty, 93, Queen's Road, Monkseaton, Northumberland.

East Midlands: H. Bunting, 17, Marcus Street, Derby.

Coventry: J. M. Meston, 37, Melville Road.

West Riding of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.

Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitechurch, Glam.

Welsh Engineers' and Founders' Association.

Secretary: T. J. Griffiths, 20, Fisher Street, Swansea.

"Body" and Liquidity.

In our correspondence column this week there appears an interesting communication from Mr. Victor Stobie, who has thought it appropriate to associate the two distinct questions of "body" and liquidity (life or viscosity), and ascribe both to the presence of oxygen in a combined form. As long ago as October 13, 1921, we pointed out editorially the possibility of the presence or absence of nitrogen being responsible for variations in what we termed "this undefinable virtue of body," and referred to the work of Mr. E. T. Moore, who ascribed the poor properties of steel, made under long arc conditions, to the presence of nitrogen owing to the institution of ideal conditions for the fixation of nitrogen. Mr. Kent Smith, in his article on this subject, elaborated this theory, and put forward a certain amount of empirical proof, but as Mr. Stobie points out, where the conditions are favourable for the introduction of nitrogen, they are equally so in respect to oxygen, except, perhaps, in the case of steel made under high voltage conditions.

In the course of a leading article in our issue for July 10, in which we emphasised the importance of Dr. Werner's statement that a process had been perfected in Germany which gave reliable results for the oxygen content of cast iron and we presumed other metals and metallic alloys, we pointed out that some investigators hold that the presence of oxygen is essential to the life of cast iron, and so, perhaps, to steel. Mr. Stobie cites a case of feeding a steel casting with unslagged steel, which we assume would have the usual carbon content of 0.07 per cent., and therefore an extremely high melting point. We presume that its carbon content of the steel would be built up to match the rest of the casting, say, 0.27 per cent., the effect of which would be to lower the melting point of the whole, leaving the difference in the two melting points to take care of the "life." Surely this is a reasonable explanation of the improvement shown.

The loss of fluidity of electric steel which has been "stewed" under reducing conditions is difficult of ascribing to iron oxides. Here the absorption from the hearth of material which remains incorporated with the body of the metal certainly appears reasonable.

Summarised, then, lack of liquidity can be ascribed to (a) iron-oxide, which theory is inclined to have fewer supporters; (b) to non-metallic inclusions, a theory of which a certain amount of empirical data already exists, and which is gaining more and more support. "Body" likewise has been attributed to (a) the absence of iron oxide, to which a cursory survey of ferrous metallurgy lends support; (b) to minute quantities of some rare element difficult of estimation; (c) to vanadium, whose direct action is often doubted; (d) to nitrogen, which again a general survey of metallurgical processes seems to support; (e) in the case of cast iron, to the size and shape of the graphite plates, which are thought by some to persist after cupola melting because of the insufficiency of time to cause dissolution.

It is thus obvious one could go on almost indefinitely bringing more and more empirical data to support this or that theory, but primarily the first essential is a reliable process for the estimation of the two gases, oxygen and nitrogen—a process which, when operated in Sheffield, Pittsburg, St. Etienne, and Essen, will record concordant results. If such a process is available, then real progress should be shown in the near future.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Percentage of Sows in Pig-Iron Deliveries.

To the Editor of The Foundry Trade Journal.

Sir,—There seems to be a great difference of opinion as to the percentage of sows or sows and runners permitted in pig-iron sent from the furnaces, when used for iron foundry purposes, and it would interest me to learn what are the rules (if any) laid down in this direction.

Perhaps some of your readers have had some experience in this direction.—Yours, etc.,

H. S.

Fluidity and "Body" of Metals.

To the Editor of The Foundry Trade Journal.

Sir,—Your interesting Leader and Mr. Kent Smith's article relating each to one of the above subjects in your current issue are, I believe, the first attempts to discuss the two points in a technical journal. It would be exceedingly valuable to the ferrous industries for a free discussion to arise in your columns out of such good subject matter, and I am sure I am voicing the feelings of most steel and iron technicians in hoping such will be the outcome.

May I give my experience and long held views? The fluidity or, perhaps better expressed, the viscosity of molten steel bears, undoubtedly, a certain relationship to its analysis as normally ascertained, but I take it that the present inquiry relates to the difference in the viscosity of different steels of substantially the same reported composition.

It is interesting to consider two steels which can be made of analyses which are sufficiently equal for the purpose in view; converter steel and electric steel for castings of, say, 0.2 per cent. carbon, 0.03 to 0.05 per cent. sulphur and phosphorus, silicon and manganese with ordinary limits. If such two steels are efficiently manufactured, we know the converter steel will contain much more non-metallic inclusion of slag-like nature (mainly silicate of manganese) than the electric steel. This is not an opinion; it has been proved metallographically time and again by well-known metallurgists.

It is common experience that converter steel is less viscous than electric steel for a given temperature, therefore, if differences in viscosity are due, as you suggest, to non-metallic inclusions, the chief such inclusion which is found in all except well made electric steel must be ruled out of consideration.

On an occasion when a large steel casting was being poured with electric steel, the mould was filled up to the header (a large one) when the quantity of steel in the ladle ran short through a miscalculation. As there was no other finished steel available, it was decided to tap half a ton of oxidised molten steel from another electric furnace and pour it into the head after killing the steel with ferro-silicon as in normal converter steel practice. This was done, and the last steel left the ladle as clear and liquid as any converter steel, yet the temperature of that steel was, not a little, but most glaringly below that at which the steel could have been used had it been well-finished electric steel. It would seem from this that the difference in the viscosity of converter steel and electric steel is probably due to the difference in quantity of iron oxide in solution in the steel.

Another point mentioned by you is the different retention of fluidity by various molten steels. In the case of molten converter steel and electric steel the converter steel will retain its fluidity longer than electric steel for a given temperature. This would seem a commercial advantage for the converter steel, but the probable reason for it is, judging from the ceaseless action seen in a ladle of converter steel, that the ferro-silicon thrown into the ladle keeps up its reaction with the, unfortunately, iron-oxide laden steel, and heat is thus added to the molten mass by this process of "steel making in the ladle."

I would suggest the possibility of the differing "Body" in steel, as defined by Mr. Kent Smith, to be due, also, to oxide of iron in solution in the steel.

Considering various types of steels, we note that the more oxidising the process of manufacture, the less "Body" is, generally, found in such steels. Taking the degree of oxidation, we have the following order:—Basic Bessemer; Acid Bessemer; Basic Open-hearth; Acid Open-hearth; Crucible; Electric. In pig-irons, we have the same relationship:—Hot-blast; cold-blast.

Mr. Kent Smith could reply that to such extent as the oxidation during manufacture was accomplished by air, the above rough order of merit of steels and irons confirms nitrogen to be the probable cause. I would, however, rather suggest that the difference in "Body" between basic and acid open-hearth steels where, substantially, the different degrees of oxidation during manufacture are the result of different proportions of iron ore added to the molten bath, confirms that "Body" in steel is, mainly, a matter of iron oxide in solution therein.—Yours, etc.,

Victor Stobie.

The Analysis of Grey Iron Foundry Alloys.

To the Editor of The Foundry Trade Journal.

Sir,—Referring to your footnote which appeared in the Journal of July 31, page 90, column 2, in which you query the advisability of using silica tubes in conjunction with copper gauze, and state preference for porcelain tubes, I am indebted for the raising of these interesting points, and will deal with them in the light of my own experience.

First, in regard to presumption that the copper oxide would unite with the silica to form copper silicate, I think that this point is of small importance, in so far as it affects the efficiency of the method or life of the tube, the penetration of the copper oxide into the tube is very slow; though I have used silica tubes in conjunction with copper gauze for as long a period as two years, I have never observed any discoloration of the tubes' outer surfaces, or any effect upon the length of life. Further, no inaccuracies were traced to this reaction; when inaccurate results did occur, they were due to discrepancies which at times creep into a day's work, regardless of the type of apparatus used.

The tubes used were of opaque silica, unglazed on the inner surface, and had wall thicknesses of about 2 mm. The gauze was changed about every six months. I fail to agree with the statement, "If a porcelain tube, which we personally prefer, the danger is lessened"; firstly, because the reaction of the copper oxide and silica is not powerful enough to constitute any real danger; secondly, because I am of the opinion that it depends largely upon the quality of the porcelain as to whether the "danger" is not actually *increased*.

The preference for porcelain tubes is, I am sure, not supported by the majority of metallurgical analysts; it is a fact that during the past few years porcelain tubes have been largely replaced by silica. The extremely low coefficient of expansion of silica is in itself a factor which fully justifies a preference for *silica* tubes.

The writer has suffered the bitter experience of cracking and splitting of porcelain tubes at most inopportune times—as during the running of a series of total carbon estimations—due to this material being less able to withstand the continual fairly sudden heating-up and cooling-down periods, than silica, which gives no trouble in this respect.

The cost of silica for this purpose compares very favourably with that of porcelain, there being little if any difference between the two.

In practice, silica works out cheaper, for with normal usage such tubes have longer life than porcelain.—Yours, etc.,

H. H. S.

P.S.—The second article of the series, published in the August 7 issue, contains an omission and an error omission, which I should like to take this opportunity of correcting.

In column 2, page 118, where reference is made to the graduations of the Eggertz tube, the

"1/10" is omitted; the sentence should read "graduated in 1/10 c.c."

Later, in the same column, referring to the inadvisability of making the carbon tests in artificial light, a sentence reads, "Further, it is invariably uniformly distributed"; this should read, "Further, it is invariably NOT uniformly distributed."—H. H. S.

[Our experience, which was contemporaneous with the introduction of silica tubes, was at a time when it was universally customary to use Berlin porcelain tubes. The copper oxide drilled so many holes in the silica tubes that we had to decide between the discarding of the silica tube or the copper gauze. The inability to procure Berlin porcelain perhaps built up a technique based initially on *force majeure* which has now become standard. There is this difference, however: Our work was mainly in connection with nickel-chrome steels, which probably necessitates a higher combustion temperature than cast iron, and so reaches the reaction temperature between copper oxide and silica.—EDITOR.]

Complimentary Dinner to Mr. Cole Estep.

Last Thursday some of the friends of Mr. H. Cole Estep, who serve on the London Council of the Institute of British Foundrymen, arranged a farewell dinner in his honour at the Engineers' Club, Coventry Street, Mr. V. C. Faulkner presiding. During the evening Mr. R. O. Patterson, the President of the Institute, presented to Mr. Estep a silver entree dish on behalf of his hosts. Amongst those present were Messrs. J. Ellis, Wesley Lambert, H. O. Slater, R. J. Shaw, H. G. Sommerfield, H. J. Maybrey, H. Shiltoe, F. Klouman, F. J. Wares, W. Lake, Frank Somers, J. A. Smeeton. Telegrams were received from Col. W. F. Cheesewright, Messrs. John Cameron, Victor Stobie, A. R. Bartlett, G. Hall, G. C. Pierce, and many others. Mr. Estep sailed by ss. *Baltic* last Saturday.

German Foundrymen's Association.

The annual meeting of the German Ironfounders' Association is to be held from August 27 to August 30, in Breslau, under the presidency of Dr. Ing Werner. Only four Papers are to be read, the titles and authors of which are:—(1) The Constitution of Moulding Sand and Its Importance in Foundry Practice, by Professor Aulich; (2) The Thermo-Technical Principles of the Cupola, by Professor Diepschlag; (3) The Beardsley Piper Sand Slinger, by Professor Lohse; and (4) The Modern Chilled Iron Griffin Wheel, by Emil Rücker.

Patent Specifications.

Particulars of complete specifications accepted, furnished by Mr. Eric Potter, Patent Agent, of Lonsdale Chambers, 27, Chancery Lane, London, W.C.2. Printed copies of the specifications in the following list are now on sale.

219,040. GRIMES, G. L. Roll-over mechanism for foundry moulding machines.

196,260. SAKLATWALLA, B. D. Manufacture of alloy steel and iron.

219,061. WESTWOOD, W. A. Siemens' open-hearth furnaces.

219,445. RATCLIFFE, F. G. Loading or unloading of muffles or furnaces.

203,688.—SOC. ANON. METALLURGIQUE D'AUBRIVES ET VILLERUPT. Control of pouring in metal-casting machines.

218,967. AJAX ELECTROTHERMIC CORPORATION. Electric induction furnaces and other apparatus heated by induction.

MR. R. F. SMITH and MR. A. HOLEMAN, carrying on business under the style of Smith & Holeman, Clayton Iron Works, Clayton Road, Peckham, London, have been adjudged bankrupts.

Book Review.

Gemeinfassliche Darstellung des Eisenhuettenwesens. Edited by the Association of German Ironmasters.—Düsseldorf: Verlag Stahleisen M.b.H., Schliessfach 664. (Price, bound, 12 gold marks.)

This well-known treatise on iron and steel making, issued by the Association of German Ironmasters, has now reached its 12th edition, which has been thoroughly revised and considerably enlarged, and aims at representing the industry from both a technical and economical point of view. The revision has been effected by the editorial staff of "Stahl und Eisen," and the managements of the Association of German Ironmasters and of the North-Western Group of the Association of German Iron and Steel Industrialists, assisted by the iron and steel industry of the country.

As regards the technical portion of the book, this has been thoroughly re-arranged. The introductory portion dealing with the terminology and characteristics of iron, the history of the subject and the section dealing with the testing of materials, have been entirely re-written. The sections dealing with the production of pig-iron and with electric furnaces have been considerably enlarged, the former with special regard to the treatment on a broader basis of the fuels and coke making. All other parts of this division of the book have been more or less revised and enlarged. There is a short bibliography at the end of Part I. Oddly enough, it ignores the new edition of Prof. Osann's book on pig-iron production.

As regards Part II, dealing with the economical aspect of the industry, this has in many respects been entirely revised and enlarged. Thus, for instance, the chapter on "The German Iron and Steel Industry during the War," being merely of ephemeral interest, has now been omitted and replaced by one (No. III) on "The Economical History of the German Iron and Steel Industry," which in three sub-divisions deals respectively with (1) the historical development of the technique of iron and steel making; (2) with the mutual interdependence of Lorraine, Germany and France; and (3) the co-operative movement in the German iron and steel industry. Next the chapters on the ore, scrap and iron trade (No. IV), the one on mergers, cartells and combines (No. VII); the Eisenwirtschaftsbund (No. IX); and labour in the iron and steel industry (No. X) have been revised and brought up to date; all other chapters have undergone similar revision though perhaps in a lesser degree.

Finally the Appendix, containing lists of and information about iron and steel works and the 1900 foundries in Germany, has been re-arranged and brought up practically to date, representing the plants as they existed in the spring of 1923.

Chapter I of Part II, containing statistical and other information about 33 different countries of the world connected with the iron and steel industry, has been retained and brought up to date, as far as possible.

THE PUBLIC EXAMINATION of Mr. J. P. Turton, carrying on business as an ironfounder at Hood Street Foundry, Ancoats, Manchester, has been fixed for September 12.

THE NEW BOARD OF DIRECTORS have taken over the control of Sheffield Steel Products, Limited, from Sir W. B. Peat, receiver and manager, and they propose to confine operations to the wholesale business. Offices have been acquired on the ground floor of Bush House, Aldwych, W.C.2.

IN THE CHANCERY COURT at Manchester, last week, the Deputy Chancellor, Mr. H. Winstanley, made an order for the winding up of the Lancashire Ordnance Accessories Company, Limited, whose registered offices and works are at Heaton Norris. The petitioners were the Scottish Stamping and Engineering Company, Limited, of Neptune Works, Ayr.

EXPLOSION RISKS OF PULVERISED COAL.—An investigation of the explosion risks in industrial plants using pulverised coal as fuel, which has been conducted by the U.S. Department of the Interior, through the Bureau of Mines, for the past several years, has now been completed. Practically all the important plants using such fuel were visited, and the installations closely studied for safety conditions and the means employed for eliminating possible risks. In some plants the Bureau of Mines engineer was able to point out dangerous conditions, and practical changes for their abatement. The results of this research show that the causes of an explosion risk are similar to those from coal dust in mines. Means of combating them are to prevent clouds of coal dust from getting into the air, and to eliminate possible sources of ignition. A report giving the result of this investigation will be issued by the Bureau within the next few months.

XUM

Mayari Pig-Iron.*

Although the book bearing this title is really publicity matter for a particular brand of pig-iron, it makes very interesting reading, as Mayari pig-iron at the moment has no *natural* competitive brand. It is a pig-iron smelted from a nickel chrome ore existing in Cuba. Obviously it could be imitated synthetically by the smelting of nickel-chrome steel scrap, of which large quantities exist as a result of the breaking up of war vessels. This we believe is being done in England by a recently-formed company.

It is interesting to note that there are large deposits of a natural nickel-chrome iron ore in the Island of Skyros, off Greece.

The book under review contains about 100 pages, of which more than half are from the pen of Dr. Moldenke, and thus commands the attention of all foundry managers.

The first section is entitled "Distinctive Features of Mayari Pig-iron," and the following claims are made for the resultant castings:—Increased strength and solidity, a better surface; reduction of sponginess and segregation: fine machining qualities, and longer life when subjected to heat and wear. As to the liquid iron it is stated to have a lower freezing point, greater fluidity, and longer life in the ladle.

Mayari pig-iron is a low sulphur and phosphorus natural nickel-chrome pig-iron, containing small percentages of vanadium and titanium. It is interesting to note that "attempts to secure better castings by additions of nickel and chromium to the cupola mixture or to the ladle proved expensive, and did not secure uniform dissemination throughout the metal." The analysis of Mayari pig-iron is:—Nickel, 0.80 to 1.25; chromium, 1.60 to 2.50; titanium, 0.10 to 0.20; vanadium, 0.05 to 0.08; manganese, either 0.60 to 1.00 or 1.00 to 2.00; phosphorus, 0.10 max.; sulphur, 0.05 max. per cent. Five grades of silicon are shown ranging from "special low" (0.25 to 0.75 per cent.) to special (2.25 and over). The total carbon depends upon the silicon content.

A long illustrated section is devoted to the "Beneficial Effect of Mayari Pig-iron in Making High-grade Castings," which gives some interesting comparative data.

It is asserted that "chromium has a strengthening effect on castings similar to nickel, and in addition the influence of chromium allows the taking up of more carbon, *i.e.*, allows the breaking up of the large weak flakes of graphite into small, well scattered flakes, in which form stronger castings are produced."

As a comparative test the book gives for a mixture without Mayari pig-iron 8.0 to 11.1 tons per sq. in. tensile; with 15 per cent. Mayari 11.1 to 16.5 tons, and with 25 per cent. 17.8 to 19.6 tons per sq. in.

It is stressed that the four elements—nickel, chromium, titanium and vanadium—are a combination essential to the results claimed.

From the section on "Wear-Resisting Castings," it is noted that an addition of 50 per cent. Mayari iron giving a Brinell hardness of 550 and over gives greater strength than ordinary castings of similar hardness.

Dealing with the incorporation of 20 to 30 per cent, Mayari iron for roll manufacture it is stated that the product has shown three to four times the service of ordinary chilled rolls. In this connection, it is interesting to note that we are aware that one prominent roll manufacturer in England uses Mayari pig-iron, whilst others rely upon the addition of 0.50 per cent. chromium.

Automobile Castings.

Under this caption, it is apparently the "foundry" properties, that is long freezing range and low freezing point, which are stressed. The following is given as an example of a typical motor casting made with 10 per cent. of Mayari iron:—Si, 2.66; P, 0.77; S, 0.145; Mn, 0.60, and T. C., 3.02 per cent. Tensile strength, 16.4 tons per sq. in.: transverse, 4,250 lbs. per sq. in. (both on American standard bars); Brinell hardness, 223 to 229. A running test showed a wear of five ten-thousandths of an inch after 45,000 miles.

High-Test Castings.

High-test castings is Dr. Moldenke's pet name for semi-steel cast iron, and one realises as his handiwork, the expression, "The mixture is commonly called semi-steel, but is nevertheless a true cast iron with a lower carbon content," yet in the next line the phrase, "The difficulties encountered in making semi-steel castings" appears, which is just another example of the uselessness of fighting against the inevitable. In this section it is pointed out that ordinarily semi-steel cast-iron has a higher freezing point and short freezing range associated with severe internal shrinkage, and that these disadvantages are counteracted by additions of Mayari pig-iron.

Heat-Resisting Castings.

No definite data is given in this section except the recommendation to use a metal having a low silicon and graphite content.

Typical Analysis Specifications.

This section of the book will be most useful to actual users of Mayari iron, as it gives the analysis to be sought and the percentage of Mayari iron to incorporate. Five pages are left blank for foundrymen to record the results they receive from actual practice.

Cupola Practice with Nickel Chromium Pig-iron.

The next twenty pages consist of an article on this subject by Dr. Richard Moldenke, and constitute an excellent contribution to the study of cupola practice. "All foundry melting processes for cast iron," says Dr. Moldenke, "now used are essentially of an oxidising character, hence the metal used in the charges cannot be too free from previous oxidation. The dissolved iron oxide in the molten iron foundry metal cannot be removed before pouring into moulds as readily as in the case of the much hotter steel. It is essential, therefore, as the scrap used is a very uncertain quantity, that the foundryman select high-grade pig-irons for his mixtures, and use them in quantity consistent with competitive requirements."

In his section "Tests Showing Effects of Nickel Chromium," the doctor publishes 150 complete analyses and the mechanical properties of each. From these he deduces that "the best strengths were obtained with low to medium total carbons, with silicon from 1.50 to 2.00 per cent. and the phosphorus low, with nickel-chromium low to medium, or in amount the same as obtained from about 10 to 15 per cent. of Mayari pig-iron added to the mixture."

The doctor's views on sulphur and manganese are interesting. He says: "The lower the sulphur, the better, though with careful melting practice and *a particularly high coke bed*—(the italics are ours, as we feel that this factor may be of help to those foundrymen making high-sulphur Diesel engine cylinders)—some excellent iron has been made with exceptionally high sulphur content. For the benefit of the foundry, however, it is best to use ample pig-iron percentages in the mixtures generally, so that the sulphur content in scrap may not eventually overwhelm the industry."

"Manganese is always best held over 0.50 per cent. and below 1.0 per cent., perhaps 0.60 to 0.90 per cent. are closer limits. Below 0.50 per cent. the protection of this element in case of oxidising accidents in melting is lost, and above the maximum there is possibility of hardness resulting from the manganese itself."

Mayari pig-iron has a high total carbon content, which is accounted for by the blast furnace conditions necessary to reduce the chromium content from the ore. "All the nickel and practically all the chromium are reduced, which results in a high-grade iron quite free from oxidation, in fact, an iron which might be given as of "charcoal iron" (cold-blast is the British equivalent) value to the foundryman."

Another interesting observation by the author is "contrary to the usual belief that much phosphorus must be had to run thin castings, this is not the case. One has but to inspect the large yet very thin malleable castings used for gear covers to see that it is possible to run quite low phosphorus iron satisfactorily, even when this iron will be white in practice in the sand or most difficult to hold fluid long."

British foundrymen will find much to interest them in this book, which is well worth the small charge made for it.

* Published by the Bethlehem Steel Co., of Bethlehem, Pa., U.S.A. Price $1.00.

Modern Methods of Pipe Manufacture by the Centrifugal Process.

By E. J. Fox and P. H. Wilson.*

Centrifugal force has, of course, been utilised by engineers for many years, but not to any great extent, nor as a fundamental basis of any manufacturing process.

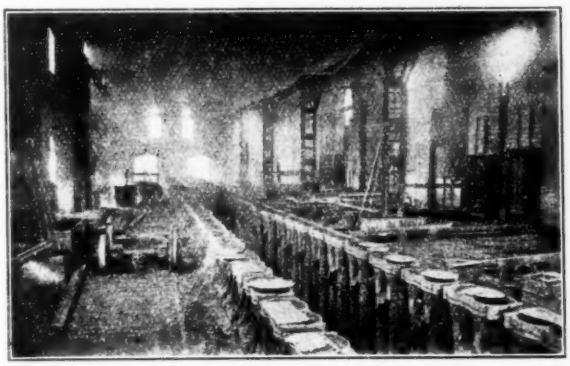


Fig. 1.—Sand-Cast Pipe Moulding Pit.

The application of centrifugal force has presented many difficulties in the past, particularly, perhaps, in regard to the treatment of molten metal. It was not until 1914, when a French engineer, Mons. D. Sensaud de Lavaud, commenced investigations on the production of iron pipes, that after a period of some years of unremitting labour, experiments and tests, involving a large capital outlay, results were obtained which added one further process to the industries of the world.

M. de Lavaud's process dispensed with the necessity of utilising sand or loam cores, which are, of course, an indispensable adjunct to the ordinary manufacture of pipes in cast iron, as shown in Fig. 1.

His process is one which revolutionises the whole system of pipe manufacture, and permits of the introduction of labour-saving devices, at the same time improving most considerably the conditions under which the worker can operate. This point is obvious from the view of a portion of The Stanton Company's centrifugal pipe-making shop.

There are, at present, only four plants in the world operating M. de Lavaud's patents (under license from the International de Lavaud Corporation, Limited), namely: in Canada—The National Iron Corporation, Limited, Toronto; in the United States—The United States Cast Iron Pipe and Foundry Company, Birmingham, Ala; in Japan—Messrs. Tsuda and Company, Osaka, and, of course, the plant at Stanton, which may be claimed to be the most modern and largest plant in existence for the production of "spun" iron pipes.

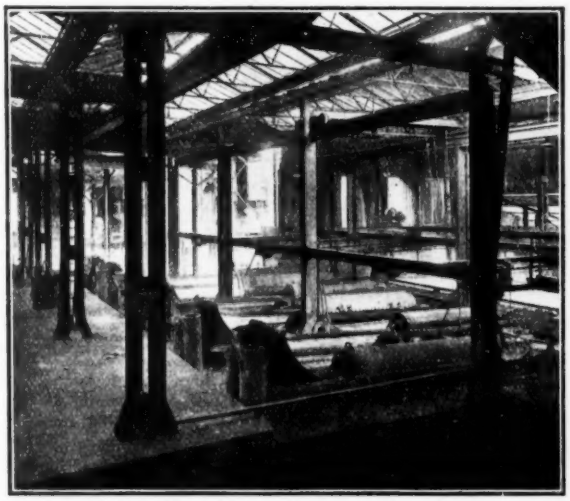


Fig. 2.—"Spun" Iron Moulding Shop.

Process Details.

The process as in operation at the Stanton Works can with advantage be briefly described: A series of overhead bunkers have been erected, into which the raw materials are discharged from wagons on an elevated railway. The structure, which is ferro-concrete with steel linings, has an individual bunker capacity of either 15 tons of coke, 40 tons of coal, 100 tons of pig-iron, or 80 tons of limestone. All the raw materials are analysed and tested in the Company's laboratories before being discharged into the bunkers, and in this way the charging of the cupolas is strictly governed, ensuring the best possible mixture of iron being used in the manufacture of the pipes. The importance that the Company places upon these laboratory analyses of all raw materials cannot be too much emphasised. Special discharge apparatus has been fitted at the bottom of each bunker, the doors of which are mechanically controlled.

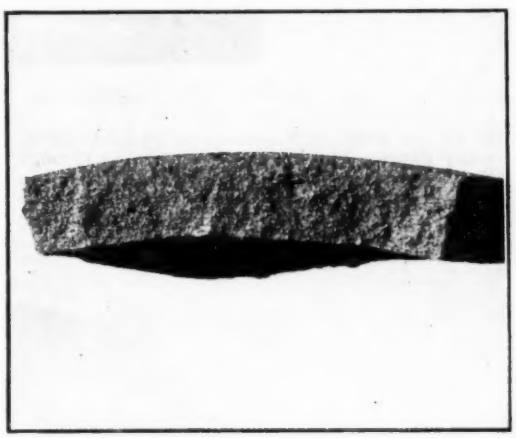


Fig. 3.—Ordinary Foundry Iron.

Feeding the Cupolas.

Travelling beneath the bunkers is an electrically operated 2-ton travelling carriage upon which is fitted a recording weighing-machine. A skip is run on to this travelling carriage from rails leading from the cupola charging hoists. The carriage traversing beneath all the bunkers, enables the skip to be brought into position beneath any particular constituent required. The operator also controls the withdrawal of the material from the bunkers overhead, so that the exact quantities as governed by the recording weighing machines are fed to the cupolas.

The skip is then withdrawn from the travelling carriage and is placed in position beneath the automatic charging hoists. These are of considerable interest, being accepted as the most modern practice for the purpose, and being the only example of this practice operating in this country. They are hydraulically operated, and the arm upon which the skip is suspended is raised to the top of the cupola. The opposite end of this arm is guided by means of rollers running on rails. These rails are so curved that the skip is taken into the top of the cupola, when the contents are discharged automatically by means of a bottom

* Respectively Managing Director and Foundry Manager—Messrs. The Stanton Ironworks Company, Limited.

discharge. The empty skip is then lowered to the carriage and returned to the bunkers.

The cupolas are of modern but conventional design, having drop bottoms. Each has a melting capacity of 10 to 12 tons of metal per hour. The blast is supplied by two fans of standard pattern, each having a maximum capacity of 8,000 cub. ft. of air per min., at a pressure of 16 in. to 30 in. water gauge. The volume of air passing through the tuyeres is governed by special recorders of the Wilson type, by which means it is possible to regulate, almost with exactitude, the melting conditions.

The metal is tapped into 3-ton casting ladles which are conveyed to the casting bays of the moulding shop by means of a 5-ton electric crane traversing a Telpher runway.

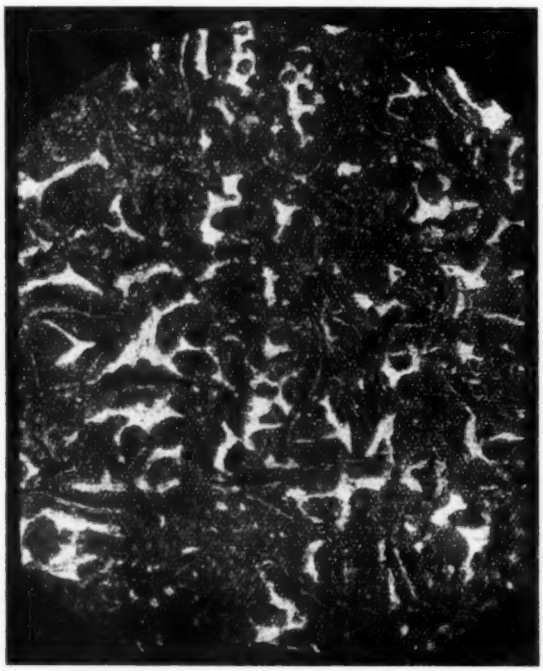


Fig. 4.—Micro-photograph of Cupola Iron.

Comparative Data.

Up to this point, the scientific nature of the control and movement of the raw material to the molten metal ready for casting, has been indicated. It will be observed that the human element is largely eliminated and that the control at all stages is predetermined, thus ensuring that the molten iron when conveyed to the centrifugal casting machines is of the correct quality and temperature. The significance of this factor cannot be over-estimated, as the iron undergoes such a radical transformation when the centrifugal force is applied that its correct condition in its preliminary state is of paramount importance.

The following comparative data in relation to the nature of the metal itself may prove interesting. The molten iron, as it leaves the cupola, is of the usual foundry-iron structure, and has an average tensile strength of 9½ to 11 tons per sq. in. A fracture is shown (Fig. 3), whilst from the micro-photograph (Fig. 4), the formation of ordinary cupola iron will be observed. The long thin lines indicate graphite carbon, the whiter portions phosphide eutectic in segregated areas, while pearlite is indicated by the blacker portions. This, of course, is the appearance of any good foundry-iron.

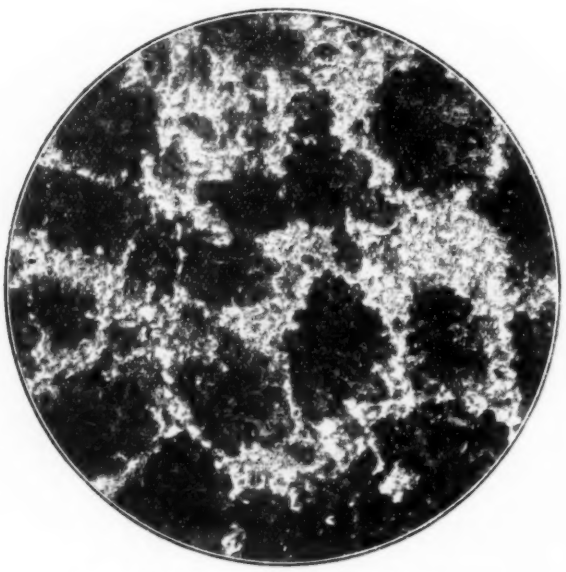


Fig. 5.—Micro-photograph of "Spun" Iron.

The iron structure, after the spinning process

has been carried out, shows that several almost startling changes have taken place. The structure is entirely free from blow-holes and is of much closer grain. From the micro-photograph (Fig. 5) it will be seen that the graphite carbon, which is of course a source of weakness, has been split up into finer particles and is more closely interspersed with the other constituents.

The "Spun" iron is therefore of greater strength, both in tensile and compression. The Company's engineers, however, do not base their belief upon laboratory investigations alone.

The de Lavaud process, being an entirely new departure from foundry practice generally, and it being seen that the iron underwent such complete changes, it was decided to carry out a series of tests, numbering no less than 10,000 extending over a period of some seven months. In order to check this experimental work, further sets of samples were forwarded to independent research laboratories, whose results confirmed, without exception, those obtained by the Company's officials. The Stanton Company thus claims to be absolved from anything in the nature of haphazard guess-work when they put forward the claim that whereas ordinary cast iron has a tensile strength averaging from 9½ to 11 tons per sq. in., "Spun" iron has a tensile strength of 17 to 20 tons per sq. in., both metals being of the same original analysis. The figures shown in Table I are indicative of results obtained daily :—

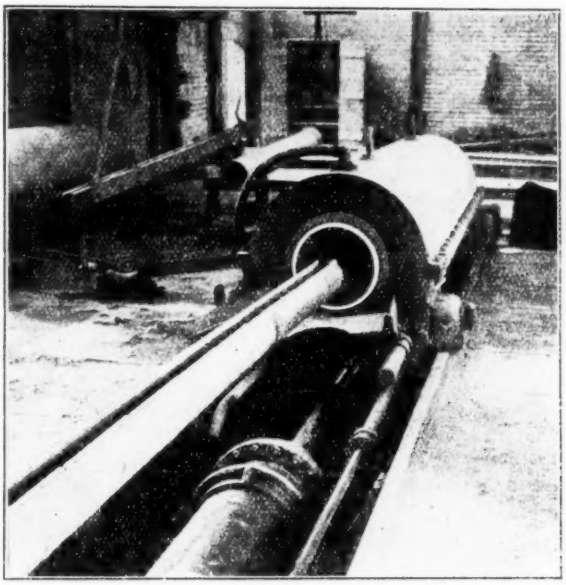


Fig. 6.—"Spun" Iron Pipe Moulding Machine.

Table I.—*Tensile Tests of "Spun" Iron and Cast Iron.*

	Diam.	Max Stress.
	ins.	Tons per sq. in.
Spun iron	0.395	17.25
	0.377	19.75
	0.374	18.05
	0.399	20.15
	*0.309	18.80
	*0.273	20.80
Cast iron	0.380	9.87
	0.386	10.35
	1.123	10.20

*Independent Tests.

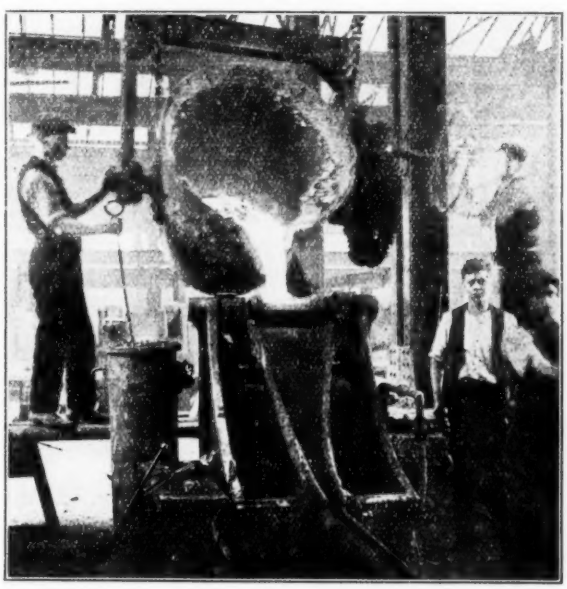


Fig. 7.—Tilting Ladle.

The modulus of rupture of "Spun" iron is high, and the metal is very ductile. On 3 ft centres, "Spun" iron will deflect from 0.45 to 0.55 in., carrying a load of from 40 to 50 cwts., whereas a deflection of 0.33 in. with a load of 28 cwts. only, is demanded under the British Standard Specification for ordinary cast iron pipes. This gives a modulus

of rupture of about 67,450 for "Spun" iron as against 45,000 for cast iron, and a modulus of elasticity of 16½ millions as against 14½ millions for high-grade cast iron.

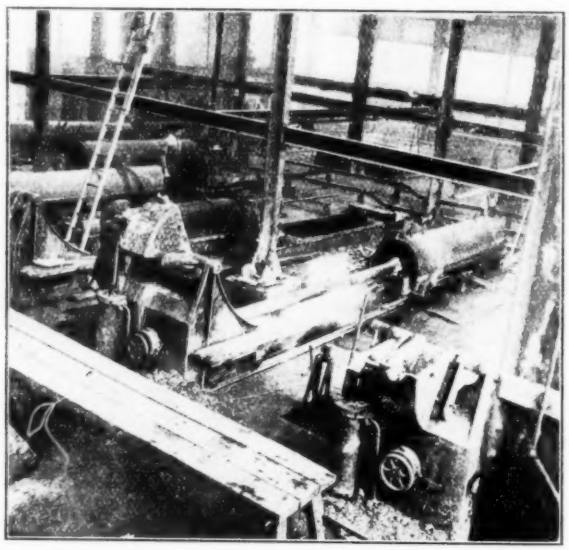


FIG. 8.—MOULDING MACHINE.

TABLE II.—*Deflection Tests.*

	Breadth	Depth	Final Deflection	Load	Modulus of Rupture	Modulus of Elasticity
	ins.	ins.		cwts.		
Spun Iron	1.004	0.388	0.455	51.6	78,000	16,300,000
	1.005	0.395	0.491	44.8	67,900	17,200,000
	0.990	0.397	0.488	46.0	69,500	16,900,000
	1.008	0.416	0.478	44.1	66,600	16,250,000
	0.229	1.000	0.499	47.8	72.400	—
	0.310	1.000	0.542	49.2	74.300	—
Cast Iron	1"×2" Standard Bars 3 ft. Centres		0.365	29.6	44.750	
			0.372	29.9	45.200	

If anything, these figures are under-estimated for the "Spun" iron. The figures marked with an asterisk were ascertained by David Kirkaldy and Son. The final deflection only was given, which, being beyond the elastic limit, rendered it impossible for the modulus of elasticity to be calculated from these results. The centres of the knife edges were 12 in., the deflection being taken with a micrometer.

The extraordinary change which takes place in the structure of the metal itself owing to its submission to centrifugal force while in a molten state is interesting.

Process of Centrifugally Casting.

The machines are fixed in bays on either side of a centre gangway, each side accommodating six machines. Pipes of 4 in. to 7 in. diameter are made on one side of the gangway and from 8 in. to 15 in. diameter on the other side of the gangway. The Telpher track runs between the two rows of machines, thus rendering it possible for the ladles containing the molten iron from the cupolas to be brought into position to feed any particular machine.

The machine itself is of interesting design. The pipe is formed in an accurately bored cylindrical steel mould, the inner dimensions of which coincide with the outer dimensions of the finished pipe, including the enlarged formation of the socket end. The mould is revolved on its own axis by means of an impulse water turbine inside a water-cooled iron casing. This revolving mould is supported at two points in its length by two sets of friction rollers which have bearings on the inside of the casing and are lubricated by grease cups accessible from the outside.

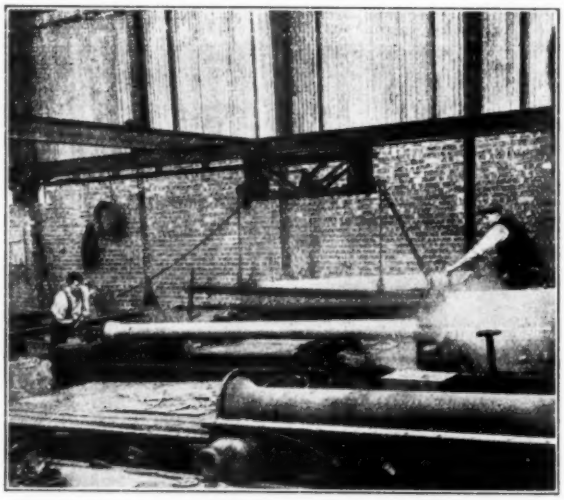


FIG. 9.—PIPE BEING WITHDRAWN FROM MACHINE.

The casing, with its revolving mould, is caused to traverse backwards and forwards on its bedplate by a hydraulic cylinder installed beneath the casing. At one end of the mould a Pelton wheel is fixed, and at the other end are gland rings somewhat similar to the collar thrust bearings employed in marine work.

Through the annular space between the cylinder and the casing, the cooling water is circulated,

being kept at a constant temperature and pressure. A tilting-ladle and a cantilever trough supply the metal to the revolving mould.

The only core used is that which is necessary to shape the inside of the socket. The bed-plate of the machine slopes slightly away from the tilting-ladle so as to give the metal, during casting, the requisite fall and ensure uniform thickness of metal in the pipe.

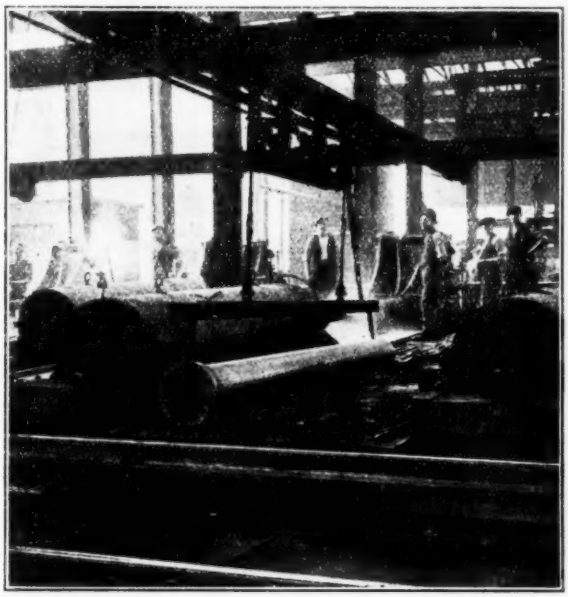


FIG. 10.—PIPE TRAVELLING TO ANNEALING FURNACE GANTRY.

The Spinning of a Pipe.

A small core, to form the inside of the socket, is clamped into position by two cotters at the socket end of the mould when at the bottom end of the bed. The tilting-ladle is then filled with molten metal at a regulated temperature being governed by optical pyrometer readings which ensures the temperature of the iron used being within specified limits.

The tilting-ladle holds slightly more metal than is required for a single pipe of the size to be cast.

The formation of the tilting-ladle is such that an even discharge of the molten metal is secured when the ladle is tilting. The movable casing and its contained mould are then moved up the bed-plate towards the tilting-ladle, the cantilever trough with its curved spout projecting down the centre of the mould towards the socket end.

The Pelton wheel propelling the mould is then started, and when the mould has acquired a proper speed the tilting-ladle is tipped forward by hydraulic means, discharging its contents into the cantilever trough. When the socket is filled with metal, the casing is allowed to traverse away from the tilting-ladle at a speed which assures the molten metal lining the inside of the mould evenly throughout its entire length.

When the mould has reached its extreme position, the spout is withdrawn from the mould, and any surplus metal in the cantilever trough runs into a side discharge.

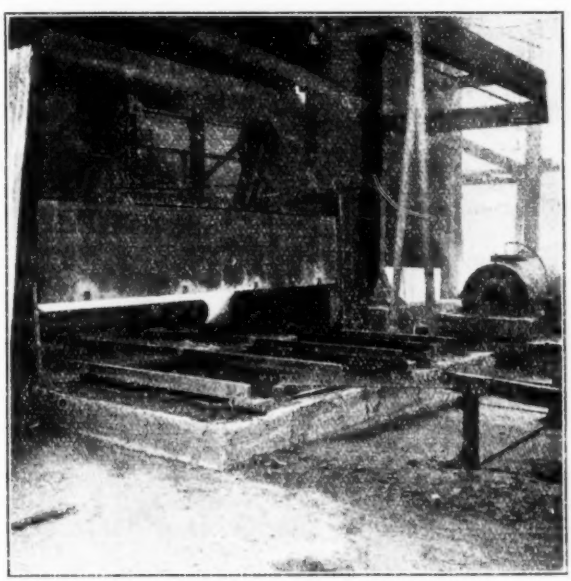


FIG. 11.—PIPE ENTERING ANNEALING FURNACE.

It will be observed that the rate of the tilting of this ladle, the peripheral speed of the mould and the traverse of the casing are all in a constant ratio for any particular size of pipe.

The molten metal, in contact with the water-cooled mould, solidifies in a few seconds, and, contracting slightly, allows the pipe to be withdrawn. This is accomplished by securing the pipe at the socket end with a special pair of internal pipe

tongs, and allowing the machine to traverse back towards the tilting ladle.

The pipe is then rolled to a small gantry between the machines, from which it is lifted and conveyed to the main gantry serving all the machines at one side of the pipe-making shop, and leading to one of the annealing furnaces.

Annealing, preferably in a gas-fired annealing furnace, is necessary in consequence of the rapid cooling of the metal in the water-cooled mould and in order to restore the homogeneity of the pipe. The pipes are withdrawn from their moulds at red heat and immediately passed to the furnace, thus conserving their residual heat. They are rotated throughout their passage through the furnace, thus not only ensuring complete annealing, but preserving the concentricity of the pipes.

The temperature of the pipes entering the furnace is about 675 deg. C., and they are gradually increased to 980 deg. C. They are then allowed to cool slowly in the lower part of the furnace and emerge at a black heat convenient for coating. The temperature is controlled by means of three Cambridge recording pyrometers, giving readings at the socket end, the centre, and the spigot end of the pipe.

The annealing furnaces are gas-fired, the gas having a calorific value of about 225 B.Th.U. The producers supplying this gas are of the Chapman floating agitator type with a water-sealed bottom (11 ft. in diameter), and are mechanically fed. Each producer can gasify 25 tons of coal per day. The coal-storage bunkers are mechanically fed by means of an automatic hoist similar in design to those used for the cupolas.

Dipping.

Upon withdrawal from the annealing furnace the pipes are cleaned and are then passed immediately through the dipping tank in a horizontal position. Upon emerging from the dipping tank the pipes are drained and allowed to dry on a gantry before being handled.

The coating mixture is of the standard Dr. Angus Smith's solution, and is heated by means of waste gas from the annealing furnace and kept at the constant temperature of 150 deg. C., being controlled by a recording thermograph. The admission of further material to the tank to replace that coated on the pipes is subject to careful regulation.

It may be of interest to state shortly the method adopted in the laboratories to test the constituents of the coating mixture. Due to the action of the heat in the tank, a constant alteration is taking place in the consistency of the mixture, owing to the high volatile nature of the tar-oils, which, combined with the tar, form the coating mixture. It is therefore necessary that the proper proportions of tar and tar-oils, of the correct analysis, be added from time to time to ensure a constant standard of mixture.

It is obvious that the time necessary for laboratory tests to be carried out with regard to the specific gravity, melting or softening point, fixed carbon, distillation, ductility and viscosity, renders it an impracticable proposition to correct rapidly any defect which may have arisen in the consistency of the mixture. The basis of each of the constituents is, therefore, standardised in regard to its relation to the various points just enumerated, and all bulk material is tested.

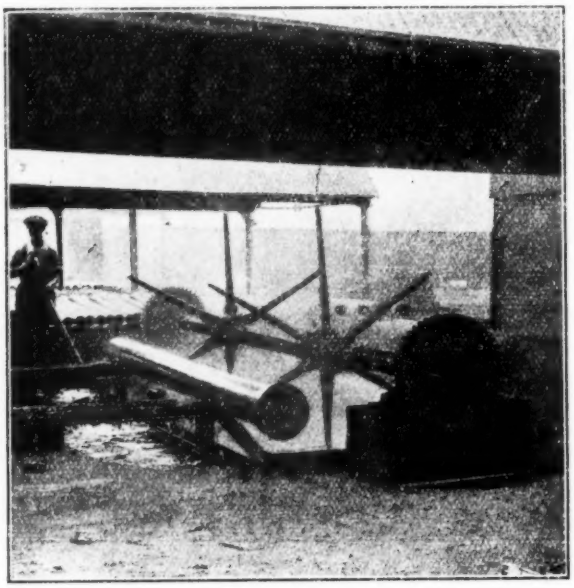


Fig. 12.—Pipe Leaving Dipping Tank.

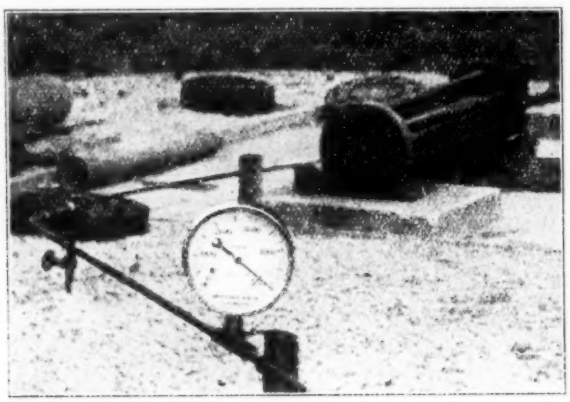


Fig. 13.—Testing a 4-in. Spun Pipe under Water Pressure.

All points now being constant, it will be seen that the proportion of the tar-oil to the tar, and, therefore, the resultant consistency, is in a constant direct ratio as to the depth of penetration.

The sample is therefore heated to a set temperature, and the depth of penetration is tested by means of a Hall-Marriott penetrometer, which is a standard instrument. From the reading on this instrument the result is compared with a standard graph, and it can be instantly seen whether the analysis is correct or otherwise. The graph was prepared from a large number of tests and checked by the results obtained by the ordinary laboratory tests for the various details previously referred to. This method we have found to be reliable, and has the advantage of allowing the dipping tank mixture to be constantly and rapidly checked.

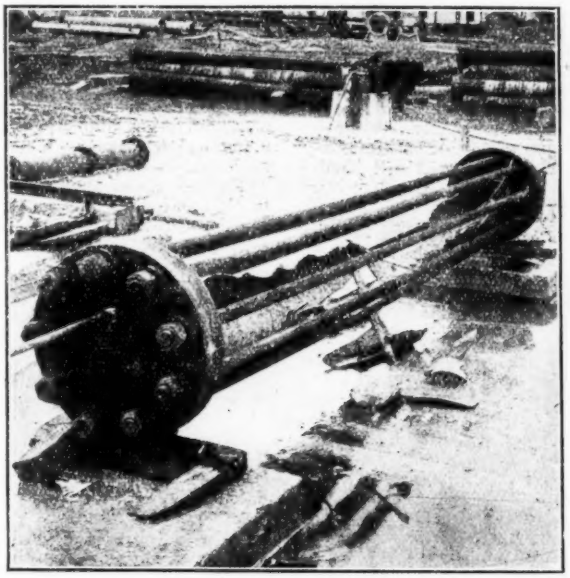


FIG. 14.—BURSTING TEST MACHINE.

The pipes, when dried, are taken to the hydraulic pumps, and are tested to a pressure at least 50 per cent. in excess of that specified in the British Standard Specification for cast-iron pipes.

The Output of the Centrifugal Machines.

The actual making of a pipe takes, on an average, about 14 secs., the complete operation from beginning to end occupying 75 secs. One machine has made up to 20 pipes per hour, giving as the maximum output of the present shop 1,920 pipes per shift of eight hours. Each machine requires the attention of four men.

The form and general dimensions of the Stanton "Spun" iron pipe follow the British Standard Specification, the external diameter of the socket being of equivalent dimensions. The "Spun" pipe will therefore "socket up" with any standard sand-cast pipe or special without difficulty.

The pipes are of excellent appearance, being very smooth both inside and out. They are perfectly straight, while concentricity is preserved to a marked degree. The section of the pipe is uniform. Circumferentially, the variation in thickness is below five-thousandths of an inch—a negligible figure; longitudinally the deviation in thickness is well below the figure allowed by the British Standard Specification for sand-cast pipes.

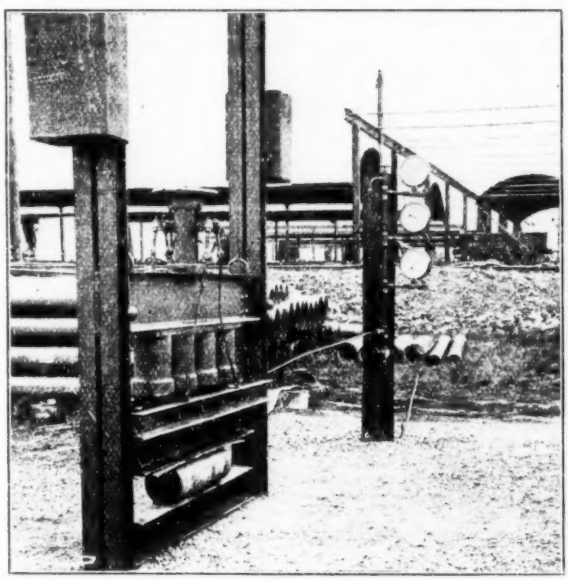


FIG. 15.—EXTERNAL LOAD TESTING MACHINE.

Before giving the results obtained from tests on the pipes, particularly relating to internal pressure, external load, transverse and Brinell test, etc., it would be useful to point out that on account of the high tensile strength of the "Spun" metal it is possible to have a thinner and consequently lighter pipe than the ordinary sand-cast pipe. The "Spun" pipe is manufactured approximately 25 per cent. lighter than the cast-iron pipe, but as the tensile strength of the "Spun" metal is at least 70 per cent. higher than that of cast iron,

the resultant pipe is, notwithstanding it being thinner and lighter, still 30 to 40 per cent. stronger—a most important factor.

Comparative Data.

The average analysis of the iron used (though excellent results are obtained from any good foundry iron) in making these "Spun" pipes is: Silicon, 2.6 to 2.9; graphitic carbon, 2.7 to 3.0; combined carbon, 0.20 to 0.40; sulphur, 0.050 to 0.068; phosphorus, 1.10; and manganese, 0.38 per cent.

The hardness of the "Spun" pipe after annealing compares favourably with that of ordinary sand-cast pipes. The Brinell number for good cupola iron ranges from 180 to 240. Specifications for cylinder iron usually require a Brinell hardness of about 180, whilst "Spun" iron has an average Brinell number of 150 to 220.

Consequently the "Spun" pipe will cut easily, machine well, and give an extraordinarily good thread. When the pipe is tapped for an ordinary gas connection the tap leaves a full regular thread, free from chipped edges.

The figures in Table III of Brinell test are indicative of similar tests carried out daily:—

TABLE III.—*Brinell Tests.*

8-in. Spun Pipe, Load 1,000 kg. Diam. of Ball 10 mm., Duration of Test, 15 seconds.

	Spigot End.			Socket End.
Outside	220	200	200	200
Edge	178	179	171	171
Inside	148	159	148	159

Samples were taken at equal distance of 3 feet.

The above tests were carried out independently by Mr. Threadgold, Chief Physical Research Engineer of the London Midland and Scottish Railway Company at Derby.

It will be interesting to note that a 4-in. dia. "Spun" pipe, as will be seen from Fig. 13, has stood 5,000 lbs. per square inch without bursting, and in point of fact such pipes have been tested to over 6,720 lbs. per square inch without any sign of bursting.

The figures (Table IV) of bursting tests require no further explanation.

TABLE IV.—*Bursting Pressure Tests.*

Size	External Diameter.	Thickness	Bursting Pressure.	Tensile Strength.
ins.	ins.	ins.	lbs. per sq. in.	Tons per sq. in.
6	6.97	0.389	3,450	13.05
8	9.12	0.392	2,750	13.65
10	11.19	0.416	2,375	13.79
12	13.11	0.422	2,000	13.46

Fig. 14 shows the apparatus for bursting tests, the burst pipe being 9 in. diameter, bursting at 2,600 lbs. per sq. in.

The next test, namely, the external load test, is carried out to ascertain the ability of the "Spun" iron pipe to withstand heavy road traffic. With a line load, "Spun" pipes will break, on an average, with the following weights:—

12 ins.	4.98 tons per foot length.	
10 ,, ...	5.41	ditto
8 ,, ...	6.02	ditto
6 ,, ...	7.30	ditto
4 ,, ...	9.19	ditto

If these pipes were in a trench—that is to say, under a disturbed load—they would carry a weight 1.9 times greater. Taking the pipes which carry the least load (which are naturally the 12-in. because of their larger diameter), a load is sustained of 9.46 tons per foot run—a figure far in excess of any load likely to be applied through vehicular traffic.

Table V shows some typical data obtained daily in the carrying out of these tests, while the method of testing is apparent from the view of the testing apparatus (Fig. 15).

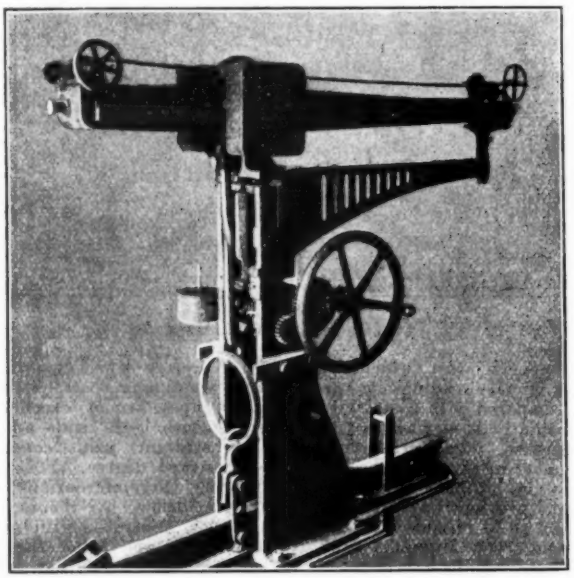


FIG. 16.—RING TEST MACHINE.

TABLE V.—*External Load Tests.*

Size	External Diameter	Thickness	Length	Gauge Reading	Load per foot.
ins.	ins.	ins.	ins.	lbs. per sq. in.	Tons
12	13.15	0.495	24	500	5.36
10	11.25	0.442	18	395	5.64
8	7.05	0.407	24	700	7.50
4	4.75	0.369	12	430	3.92

The next tests are the deflection tests, which are carried out to ascertain the flexibility of the "Spun" pipes when laid in moving or settling soil.

The comparison (Table VI) between a 4-in. sand-cast pipe and a 4-in. "Spun" pipe is given as an indication.

TABLE VI.—*Deflection Tests.*

Size.	Load.	Deflection.	Breaking load.	Maximum Deflection.
	lbs.	ins.	lbs.	ins.
4-in. Cast iron ..	4,810	0.723	8,550	1.358
4-in. Spun Pipe	4,960	0.725	11,680	1.945

In both cases the centres of the supports were 10 ft. apart, and the load was applied at two points 4 ft. apart. This means that for a load of 5.2 tons a "Spun" pipe will deflect nearly 2 in., while a cast-iron pipe will carry only 3.8 tons with a deflection of about 1⅛ in.

Owing to the difference in the metal before and after spinning, it is impossible to spin the usual test bars for tensile tests, and special arrangements had to be made to test the tensile strength of the "Spun" iron; a ring test was therefore designed whereby a ring is cut from the pipes manufactured—such rings having parallel sides and being of a width not exceeding 1 in. In practice the rings

cut from the pipes are 1 per cent. of the number of pipes made, and the rings are cut from the spigot end of the pipes.

The method of testing is shown in Fig. 16, and from the results obtained the tensile strength is calculated, utilising the formula given.

Formula for Ring Tests.

$$f = \frac{Wd}{cbt^2}$$

Where c = a constant = 4,000; W = breaking loads in lbs.; d = mean dia. in ins.; t = thickness in ins.; and b = breadth in ins.

The constant of 4,000 was obtained after innumerable experiments.

The tests in Table VII are typical of those obtained daily.

TABLE VII.—*Ring Tests.*

Size.	External Diam.	Thickness.	Breadth	Modulus of Rupture	Tensile Strength
ins.	ins.	ins.	ins.	lbs. per sq. in.	Tons per sq. in.
4	4.75	.310	1.020	81,200	21.30
6	7.07	.340	1.003	76,400	20.00
8	9.12	.362	1.005	74,000	19.40
10	11.27	.398	1.025	73,200	19.15
12	13.14	.428	1.011	68,800	18.00

It will be agreed that the figures given are sufficient evidence that the "Spun" iron pipe as manufactured at Stanton gives an excellence of quality hitherto unknown with iron pipes.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

A Comment Upon the Methods of Judging and Mixing Pig-Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Now that Mr. Young has put forward views representing the ultra scientific side of this question, perhaps the views of an old foundryman may be of interest as representing the smaller foundries.

In how many foundries is iron really mixed and melted to analysis?

The writer ventures to think very few. It is almost impossible under the everyday working conditions as at present existing.

For many years past it has been constantly pressed upon the iron makers to sell by analysis, and no doubt many of them have been put to great expense and trouble in trying to do so, and, of course, some have come very near the mark.

This constant pressing has at times been so great and the arguments put forward have been so strongly in its favour that it was thought if only it could be achieved the foundryman would for ever be in a position to give the critical engineer castings of any analysis his fancy called for. The pig-iron would be brought into the foundry and taken charge of by the chemist, who knows exactly what its properties are. He then would receive instructions from the foundry manager to have a certain quantity of metal ready by a specified time, and all particulars for which this metal is wanted and what it is expected to do.

The chemist would then sort out the various brands of pig-iron and get all things ready for charging, and when that time comes he would proceed somewhat as follows: Coke bed about 18 in. above the tuyeres, fire well up, so much pig, so much scrap, so much coke, so much limestone or its equivalent, and would repeat this until the whole of the metal required was obtained. Should, however, the casting which is made from this mixture be analysed it is very doubtful if it ever comes up to expectations.

There are so many unknown factors at work, such a large element of uncertainty about the whole working of the cupola, that makes the above statement plausible.

The scrap, the coke, the cupola lining, the rate of melting, the blast pressure, the temperature of the metal when tapped out, the condition of the ladle into which it is tapped, the material of which the mould is made, the temperature of the mould at the time of pouring, the rate of cooling all apparently can affect the composition of the metal.

What a lot there is yet to learn before castings can be produced to analysis!

However, the best results, to my knowledge, were obtained many years ago by the late Mr. C. Morehead, who used to melt scrap by itself and pour it into pigs; then analyse them and mix it with pig-iron for a second melt, using one cupola for this mixture only, so getting fairly constant results.

With the keen competition for work in foundries to-day it is not possible for many founders to adopt this method in consequence of the expense.

It is very amusing to read advertisements in the technical papers for foundry managers and foremen, who must have a thorough knowledge of the chemistry of metals and be quite capable of mixing to analysis. It is very seldom realised what this involves. It might just as well ask for a qualified chemist with a thorough knowledge of foundry work (which includes moulding). All this goes to show that something is being asked for which cannot be supplied.

By the great importance attached to the science of metallurgy in these days one would almost think that no real good castings were ever made in the past without analysis. Yet we all know full well there have been many very clever foundrymen who have produced wonderful pieces of machinery without any knowledge of chemistry. Some foundrymen have been known to judge the quality of pig-iron by tapping it with a hammer and listening to the sound emitted. I feel sure that to make the chemist's work effective the experienced foundryman must be taken into consideration and consultation.

There are many foundrymen now who could mix metal by fracture and give as good results, if not better, than any chemist can by mixing to analysis. The fracture grading, in addition to analysis, will, I think, always play a very important part in the selection of pig-irons.

I have the greatest respect and regard for our chemists, and I know their work is very trying and exacting. The methods of analysing, according to Mr. Young, are not always as they should be, and the apparatus so delicate that it is so easy to go wrong. Apparently it is quite a question if two chemists analysing one piece of iron would arrive at precisely the same conclusions.

With regard to the blast furnace, it has been said that of about sixty tons of ore smelted—all of which was put into the furnace to chemical analysis—three distinct qualities were obtained upon grading. Now if this is the general rule how then can the iron maker produce to analysis? I suppose the method employed would be to analyse several bars of pig-iron from the cast and then sell that pig to the analysis obtained, then the only way apparently would be—so far as castings are concerned—to analyse the castings and sell them accordingly, thus guaranteeing the analysis of the castings. But I doubt if any iron casting can be produced to a predetermined analysis.

Perhaps the best possible method to employ to enable the foundryman to give castings to specified analysis would be to produce a pig-iron which would when melted in the cupola alone, without the addition of any other iron: but this would be very expensive.

A very cheap and perhaps safe way is to secure the services of a good, experienced foundryman, and let him select the irons best known to himself, and mix and melt them to give the results required, and he will not be very far out. I have known men to put all sorts of things into the ladle when the metal is flowing into it, when the metal is required for a very important piece of work. I even heard of a man putting a double handful of florins into a ladle of metal. I am not a chemist, therefore I do not know what effect this addition of silver to molten iron would have in the casting: perhaps some of our chemists can tell.

Yours, etc.,

AN OLD FOUNDRYMAN.

MR. G. INGLIS, of Airdrie, died recently. The deceased established in 1885 engineering and boiler works in Cairnhill Road, Airdrie, as G. Inglis & Company, Limited, Albert Works. Mr. Inglis was managing director of this company, and also deputy chairman of Alex. Shanks & Sons, Limited, Dens Works, Arbroath. He was chairman of the Scottish Ironfounders' Association, and a member of the Scottish Boiler Manufacturers' Association and the North-West Engineering Employers' Federation.

IN THE CHANCERY DIVISION, Mr. Justice Romer heard a petition by W. S. Laycock, Limited, for sanction to a scheme of arrangement with its debenture stockholders and unsecured creditors. The scheme provided that Charron, Limited, should procure to be raised a sufficient sum to pay the debenture stockholders 5s. in the £ cash, together with the costs incurred in connection with the previous schemes, the winding-up petition, and the debenture holders' action. In consideration of those payments the guarantee of the Charron Company was to be released. The unsecured creditors of Laycocks were to receive certain deferred certificates from Charrons. The petition was opposed by the holder of £4,000 debenture stock on the ground that it was not in the least for the benefit of Laycocks, but solely for the benefit of Charrons. His Lordship confirmed the scheme.

Discussion upon Mr. O. Smalley's Paper on "The Cylinder Problem."*

Mr. Harold Thomson (Vice-President), opening the discussion, touched upon the necessity for further scientific investigation into the art of producing sound castings, and said he thought that Mr. Smalley's Paper had gone a long step in that direction both with regard to cylinders and other castings. He supposed that the experience of most people was with the castings after they had been delivered to the shops, but now they had heard the foundry side of the question. He would like to know what the lecturer would suggest, from the foundryman's point of view, as a substitute for the Brinell hardness test.

Mr. A. D. Bruce (member) agreed with Mr. Smalley that, in a certain sense, the engineer did not give much practical assistance. In looking at the question from the engineer's point of view, however, he felt that perhaps Mr. Smalley had given the designer a subordinate position. In the case of marine-engine-cylinder castings, he thought that many of the improvements in reliability had resulted from alterations in design, but he had no doubt that much of the inspiration that the designer had got had come from the metallurgist and the foundryman. Mr. Smalley had mentioned that a well-designed casting was one whose sections were no thicker than was essential to the desired unit of strength, and he (Mr. Bruce) would like to know what the desired unit of strength was. He would like to have the author's views upon Muirhead metal and to know its composition, and he would also be glad to have his opinion upon the value of annealing.

Is Special Pig Necessary for Good Castings?

Mr. W. J. Paulin said that the author naturally endeavoured to make a good case for the scientific control of the foundry, but one wondered whether it was any longer necessary to press that point.

Mr. Smalley had mentioned the milling of sand for dry sand moulds, but was that not rather an uncommon practice, and did it not tend to diminish the ventilation?

He did not understand Mr. Smalley's remark that very few managers and foremen would guarantee their castings, because, of course, the firm must guarantee the castings, and it was difficult to see how the foreman could escape doing so, at least by implication.

In speaking about cupola-melted grey iron, Mr. Smalley had referred to the selection of pig on the basis of chemical composition, but he (Mr. Paulin) presumed that it would be impossible to analyse every pig, and therefore they must judge by the relative appearance of the fracture of the neighbouring pigs at the time of analysis.

Mr. Smalley had stated that he prepared a special pig-iron in chill moulds, but did he consider this necessary to the production of good castings? He (Mr. Paulin) thought that it would be difficult, in these days of keen competition, to secure work on such lines.

The lecturer had shown some varying tensile strengths obtained from the cylinder iron of different thicknesses. The most important feature controlling the tensile strength was undoubtedly the variations in rate of cooling, for would it not be more uniform throughout with approximately simultaneous cooling?

Mr. Smalley had said that mechanical chills were a common cause of premature cracking in service. His own experience, however, was different from Mr. Smalley's, and he had used chills with perfect confidence in the knowledge that he could secure great freedom from porosity and open grain. They now used semi-steel for the production of small cylinders, and it had been markedly successful on account of its close grain and the good polish that could be obtained, and also because they could use chills on heavy bosses and get good results. It would be interesting to hear Mr. Smalley's views upon the use of semi-steel for cylinders.

American Locomotive Cylinders.

Mr. J. W. Hobson (member) said that American locomotive cylinder designs were much more complicated, but he could not say definitely that they had less rejections than the British. He understood that the American cylinders were softer than the British, being cheaper in machining operation but not having the lasting qualities in service.

The author had referred to his experience in the case of a certain cylinder of old design which had been altered to meet modern conditions. He (Mr. Hobson) also had had experience with that design, but, fortunately, they had not experienced the extreme difficulties described by the author, although the additions to the original design undoubtedly added to the difficulties of founding. Their usual procedure in the case of new designs or modifications was to bring the designer, the patternmaker and the founder together for a discussion before issuing the working drawing and making the patterns, and he thought that this fact might be responsible for their success.

On the motion of Mr. C. Waldie Cairns (Vice-President), a vote of thanks was unanimously accorded to Mr. Smalley for his Paper.

The Moulder and the Scientist.

Mr. H. J. Young (member) wrote:—The major difficulty of anyone whose duty it was to apply science was that of expressing his opinions in such terms and in such manner as to make them forceful and, at the same time, palatable to those whose education and experience had been in other directions or upon a lesser scale.

It was unfair to blame the moulder for a failure if there was no convincing evidence that the fault was his. The possibility of obtaining a sound casting did depend, and ever would depend, partly upon past experience and partly upon chance. What success in this world did not depend more or less upon these two factors?

It was untrue, as a general rule, to say that science or any innovation was deeply resented by the moulder, and resentment of this kind was generally due to the scientific man's lack of understanding and appreciation of the practical man's point of view and personality.

The author complained that the foundryman was very reluctant to change his raw materials if those in use were giving satisfaction. That was an extraordinary charge, because, even if a material was no better nor worse than another, it did not follow that the man accustomed to working with the one would meet with equal success when he changed over to the other. The reluctance complained about by Mr. Smalley therefore was often a blessing in disguise, and prevented the indiscreet adoption of "gambles."

After criticising the empirical methods of the moulder, the author said:—"It was remarkable that good castings were still being produced from such empirical data, and (it) spoke highly for the skill of the moulders." It spoke just as highly for the empirical data as for the man using it that good castings were so produced. Mr. Smalley condemned the methods devised and used successfully by the man he applauded.

The moulder's experience was not founded upon sand, even though the castings were, and nothing Mr. Smalley might say could detract from the wonderful methods built up by the moulder on empirical reasoning. Much remained for science to do, but it must have respect for the knowledge of the practical man, and it must be willing to co-operate.

Do Two Similar Irons Exist?

Whilst agreeing with what the author had said about graphite, he (Mr. Young) could not, for one moment, agree that it was common to obtain from two irons of similar chemical composition, cast under identical conditions, widely different mechanical properties, because he had seen no proved instance of this phenomenon in any two normal grey irons. Out of thousands of analyses of test bars, taken over years of practice, he possessed but one or two bars of precisely similar composition,

* This Paper was read before the Sheffield, Birmingham and Coventry Branches of the Institute of British Foundrymen and also before The North East Coast Institute of Engineers and Shipbuilders. The Paper and the discussion before the I.B.F. was published on pages 147, 173, 195 and 241 of Vol. 29. The above is an abstract from the Journal of the N.E.C. I.E.S.

and his records went to prove that when two bars were almost alike in composition and in cooling conditions, so were the tests almost alike. He was not referring to pig-irons or crucible irons, but merely with regard to cupola metal as used in commerce.

The two pig-irons shown in Fig. 9 had very different carbon contents, and therefore would behave differently. If the author's contention is that the difference lies in the fact of one being a sand-cast hot-blast iron and the other a cupola-melted chill-cast, then he could not agree with him. Two equally clean pig-irons of similar composition would give similar results, no matter how the pigs have been produced—but possibly the author holds the same views.

Mr. Smalley's remarks about phosphorus in cylinder castings were interesting and valuable, and what he said about scum and its identification confirmed what had been pointed out by Mr. Wood and the writer.

The author knew full well how much he (Mr. Young) had appreciated his work in the past, and it was with regret that he now criticised adversely Mr. Smalley's attitude as a works chemist dealing with men of lesser education than himself—men who made no pretence of a knowledge of science, who did not know what science was. It was up to the chemist to show him, not to fight him.

MR. MILLS wrote referring to Mr. Smalley's remarks as to a superheated steam loco-cylinder, and expressed the view that it was true that the design was in need of improvement, but successful castings had been made without the modifications suggested by Mr. Smalley.

Some locomotive specifications demanded that the metal to be used in casting cylinders must be seven times poured. Will Mr. Smalley give his opinion as to whether this would break up the large graphitic structure shown in Fig. 9 (*a*), or whether chill moulds were essential? Also would the use of chill moulds eliminate the expense of the specified procedure? The author appeared to have been very successful with metal cast to the American specification; indeed, local experience of American cylinders suggested that he had been more successful than the American manufacturers themselves.

THE AUTHOR'S REPLY.

MR. SMALLEY, in reply to Mr. Harold Thomson, said that the Brinell hardness number of cast iron did not bear a direct relation either to the chemical composition or rate of cooling during solidification. It was questionable whether the test gave any information as regards the wearing properties of cylinders or liners. It was of value in individual foundries running certain known mixtures from day to day, and afforded useful information on the texture, solidity and machinability of cast iron.

A test used by the author for measuring the wearing properties of cast iron was to run a small cylindrical test piece—cut from the casting—in contact with a hardened steel plate, which was made to revolve at a speed bearing some relation to the running speed in service. The test piece may be loaded on to the rotating plate to any desired pressure.

In reply to Mr. Bruce, Mr. Smalley said that Muirhead metal was a refined pig-iron which was supplied in various grades. The following was a typical analysis:—Graphite, 1.21; comb. carbon, 0.65; silicon, 1.32; manganese, 1.31; phosphorus, 0.091; and sulphur, 0.072 per cent. The principal feature of this iron was the low total-carbon content. In this respect it differed from ordinary hot-blast pig-iron, and enabled a better control of the graphite content in the finished castings. For melting in the cupola the ordinary cold blast iron was favoured because of the superiority of its property of blending with other irons and because it would carry greater quantities of domestic scrap.

Annealing Cast Iron.

The strength of cast iron should not deteriorate by annealing if that was correctly performed. An investigation into the question showed that ordinary cast irons retain a good strength at temperatures up to 900 deg. F., and that the strength was little affected by annealing the casting at about this temperature, which was sufficiently high to remove casting strains.

An annealing temperature of 1,100 deg. F. was urged by some authorities. The fall in strength, after soaking at this temperature, would be determined by the time factor. If the period of time be extended or the furnace temperature not under accurate control, the cylinder might lose more than half its original strength and increase considerably in size. The growth of cast iron was, however, closely related to the rate of cooling; for this reason annealing should always be followed by a slow cooling.

In reply to Mr. Paulin, the author insisted that science must help the foundryman to find out the physical properties of his raw material, but this did not imply that good castings cannot be made without technical control.

How to obtain Maximum Strength in Cast Iron.

With regard to the milling of sand for dry sand moulds, most foundries did this. Over-milling was certainly derogatory to the venting capacity, but sand, like steel, was a raw material whose best properties could only be obtained after correct treatment.

In reply to Mr. Paulin's reference to the guarantee of castings, there were few foremen who were able to guarantee the first casting of a new design. It was not uncommon to see the first few castings scrapped, and yet the company must guarantee a specified number of sound castings. It was the difference between the number of castings made and the number delivered that determined the efficiency of a foundry.

Mr. Paulin's experience with the variation of the composition of ordinary hot blast iron confirmed general experience, and, as he remarked, one cannot test every pig; moreover, fracture was not a reliable guide. It was for these reasons that the author found it profitable to prepare special cylinder irons to a precise chemical composition. The extra cost incurred in manufacture was more than counterbalanced by the saving effected from consistent production of sound castings.

With regard to Mr. Paulin's query about varying tensile strengths obtained from iron of different thicknesses, the author referred him to his Paper "Cast Iron and Mass Effect." In this research it was shown that there existed for each grade of cast iron a minimum rate of cooling, which yielded, within practical limits, the same grain or density, regardless of section or dimension of the casting when poured with a suitable degree of superheat. Consequently, by speeding up solidification to this critical rate of cooling, the tensile strength would be more uniform throughout, irrespective of the dimensions of the section.

Behaviour of Chills.

In part, this answered Mr. Paulin's query regarding the use of chills. Where chills could be arranged so that the rate of cooling of the heavy section was speeded up to that of the lighter, chilling can neither cause internal strains nor machining difficulties. In many designs the change of section was abrupt, and iron or steel chills on the heavy sections were fraught with danger. If slightly over-chilled at the junction of the heavy and light sections, the iron was white and liable to sudden cracking in service. If the chills were placed so that a uniform rate of cooling was obtained, stresses would still be set up at the junction of the chill and sand. Experience with chilled Diesel liners had proved costly.

On the other hand, irons having a wider margin between the white and grey conditions permitted a wide latitude in the use of chills. For instance, the central core of the ordinary marine-engine piston may be made in iron or steel without risk. The chilling effect of this core was such as to closen the grain without affecting the machining properties, whilst there was little or no danger from casting strains.

Defects of Semi-Steel.

In reply to Mr. Paulin's query regarding the value of semi-steel for cylinder castings, semi-steel was a material that could be claimed to have gained international reputation. Its successful use seemed to be restricted to those familiar with the fundamentals of scientific melting, who understood its casting peculiarities and who were not beset by foundry prejudice. The principal difficulties with semi-steel were its ready oxidation during melting, affinity for sulphur and short fluid life.

For cylinder castings 5 to 40 per cent. of steel might be used, according to the result desired and the class of cylinder made. For castings of complex design the author found that the best results were obtained from 15 to 20 per cent. The quantity, however, was a variable determined by the cupola practice and pig-irons used. Phosphoric irons low in manganese, and basic irons should be used sparsely; hematite and pig-irons low in total carbon and phosphorus and high in manganese were preferred.

In reply to Mr. Hobson, the author said that the assertion made by older railway engineers "that owing to softer castings they could not get as long a life out of cylinders as used to be obtained," surely requires some modification. The higher steam pressures and service conditions of the modern locomotive scarcely permitted a comparison of the cylinder of to-day with that of, say, fifteen years ago. It was true, however, that little was known of the relative wearing qualities of cast iron, and it was here that the engineer could assist the metallurgist.

The Bureau of Standards in America had already done much good work on these lines. So far the results showed the harder cylinder to have a longer life than the softer, but from the high percentage of softer cylinders which had given better service and had a longer life than the harder, no definite conclusions could be drawn.

The procedure adopted by Mr. Hobson with regard to new designs of co-operation of designer, patternmaker and founder before issuing the working drawing and making patterns, presented the solution to many of the common troubles of cylinder castings, and was the safest method for economic production.

The Roll of the Skilled Moulder.

In reply to Mr. Young's correspondence, Mr. Smalley wrote that the contention that the manufacture of a casting must always depend upon the moulder's experience and chance was the surest way to bring a foundry into the bankruptcy court that he knew. According to Mr. Young, if the moulder had not the experience, he must take the chance, and the chance would be a bad casting.

Mr. Young's comments on sand testing were unfair. Sand tests had a practical value. Mr. Young referred to a gamble in the changing of raw materials for something better and cheaper. Unless a foundryman testing those raw materials, and knew what they were capable of and how they were to be treated, how could their economic value be determined? Sand is a raw material whose best properties were not obtained in the raw state, and it required special treatment. To make a casting without a knowledge of those physical properties was surely a gamble. To understand and control the properties of sands was the only way he could suggest to place manufacture on a sound basis.

In a certain foundry in America 8,000,000 cylinder castings were made per annum without the assistance of any skilled moulders. In this foundry the sands were specially prepared, tested and controlled in a department for that purpose. Many more examples could be given both from this country, the Continent and America, of castings made without "the aid of the wonderful methods built up by the moulder upon empirical reasoning."

When are Test Bars Alike?

In regard to Mr. Young's criticism on the chemical composition and the physical properties of grey cast iron, if Mr. Young had made so many thousands of test bars and never met the phenomenon referred to, it would be futile to quote figures that he had obtained to convince him. He wrote: "The whole of my records went to prove that when two bars were almost alike in composition and in cooling conditions, so were the tests almost alike." The word "almost" is vague. If he had not met the phenomenon, why were the tests not exactly alike?

To prove mechanical suspension of graphite in molten cast iron, Mr. Young should investigate the effect of casting temperature on graphitic irons. If, as the carbide theory suggests, molten grey cast iron was a true alloy, *i.e.*, all the graphite was in solution, then the bars cast hottest should be the weakest. In normal cupola practice he would invariably find that casting hot gave the best test results.

In reply to Mr. Young's final paragraph, he had never occupied the position as works chemist in a foundry. Mr. Young, however, was quite correct in saying that the works chemist must not fight the moulder, his duty being to test raw materials and deliver good metal.

Multiple Remelting Inefficient.

In reply to Mr. Mills, Mr. Smalley wrote that at this juncture of the foundry industry the fact must not be lost sight of that perfect metallurgical control was not yet accomplished in all foundries. It was admitted that any casting could be made solid without assistance from the designer, but such practice would prove costly to both the founder and the engineer. Valuable assistance might be rendered by the designer's avoiding abrupt changes in section by proportioning his sections so as to obtain a uniform rate of cooling, and by appreciating the fact that the thickening of a section did not necessarily add to the strength.

In reply to the query regarding the use of cylinder iron that has been seven times poured, this is a practice which could not be recommended because of cost and uncertainty of the results. If melting was repeated seven times the original characteristics of the iron might be so changed that the process might prove more injurious than beneficial. As 6 per cent. by weight of the total quantity of iron melted was lost each time the iron is melted in the cupola, and as the desired chemical composition could be produced from a single melt there was nothing to be gained by repeating the process. If the iron was prepared to such a specified chemical composition, chill cast pigs were not essential. It was only when high proportions of a soft iron having a coarse graphite structure were used in the preparation of a special cylinder stock iron that chill cast pigs are recommended. Apart from the physical form of the graphite, however, chill cast pigs recommended themselves because:—(1) The preparation of a chill bed costs less than half that of the said bed; (2) the absence of sand and oxide ensures a cleaner and more fluid iron; (3) they save labour in breaking and handling; and (4) being uniform in form and of small dimension, it is possible to increase the cupola capacity and reduce the coke consumption without affecting the temperature of the metal.

He was at a loss to understand Mr. Mills' reference to the American cylinder specification. He neither referred to this in his Paper nor did he use or advocate American cylinder mixtures.

Life of Cast-Iron Chill Moulds.

Mr. H. Shrokawa, writing in a Japanese contemporary, outlines some experiments on the life, resistance to oxidation, warping, etc., of cast iron moulds which have been subjected to repeated heatings. He draws the following conclusions:—

Shortness of mould-life can generally be ascribed to (1) metal too high in combined carbon content; (2) too high a silicon content, associated with insufficient total carbon; (3) phosphorus greater than 0.2 per cent.; and (4) a copper content greater than 0.2 per cent. After some time the oxidation of the chill takes place from the inside to the out. After 40 or 50 casts the oxide layer attains a thickness of 7 to 15 mm. The interior surface then commences to open, it becomes rough, and finally scales. The character of the graphite has great influence on the life of the chill, for if it is too massive it readily lends itself to rapid oxidation. The addition of small quantities of chromium tends to improve the quality, the chill becoming both stronger and harder, its grain closer. This is due to the graphite being in a small curly form evenly disseminated throughout the mass associated with well-defined pearlite. The composition recommended as being particularly good is: Total carbon, 2.5 to 3.5; combined carbon, 0.8 to 1.0; silicon, 1.0 to 2.0; manganese, 0.5 to 1.5; chromium, 0.05 to 0.5; phosphorus and copper less than 0.2 per cent. and sulphur as low as possible. Wherever possible it is preferable to reheat the chills before casting to about 80 to 100 deg. C. or even higher. Up to 7 tons, the ratio between the weight of the casting or ingot to the chill or ingot mould should be about 1 to 1.6; for larger weights a ratio of 1 to 1 is satisfactory.

Is the Lanz Method Essential to the Production of Pearlitic Cast Iron?

Some discussion has arisen out of an article by K. Emmel, published in "Stahl und Eisen" some time ago on the Lanz method of producing pearlitic cast iron, the writer having asked whether it was indispensable that this particular process should be used in order to get a pearlitic structure in cast iron.

Criticism from Inventor's Works.

Replying to the writer of the article, H. T. Meyer, one of the departmental heads at the Lanz works states that pearlitic cast iron is not merely a cast iron in which the pearlitic structure occurs along with other important constituents, for the whole structure of this particular type of cast iron exhibits the pearlitic structure, and ferrite and cementite are eliminated. In criticising the process the physical qualities of the material should be borne in mind as well. The discoverers of the process at the Lanz works found that the highest mechanical properties of the cast iron they were experimenting with were exhibited by those parts of the casting that exhibited the purely lamellar pearlitic structure. The result of this insistence on the structure of the material was that all other considerations, such as hardness and tensile tests, were placed in the background, and the microscope chiefly used as a criterion of the qualities of the material. Thoroughly conscious of the vital importance of the structure—which is everything—the inventors practically revolutionised the conceptions that had previously existed in the manufacture of grey cast iron, by tackling the problem from the standpoint of metallography, and setting themselves out to solve an entirely new problem. This is the pith of the Lanz discovery and process. Briefly, it broke new ground, in that it sought deliberately and consciously, to change the material entirely by changing its structure.

As a necessary corollary, and in order to get a certain definite structure, definite rules were laid down regarding the composition of the charge from which the material was made and the rate at which it was cooled, these being adapted to each other in such a way that the pearlitic structure predominated in the material. Any alteration in the constituents of the material necessarily implies a difference in the rate of cooling, and *vice versa*. The thickness of the casting does not actually affect the rate of cooling, but since the cooling conditions are different in light castings to what they are in heavy castings, certain precautions have to be observed so as to get the same cooling conditions in castings of different thicknesses, *e.g.*, the rate of cooling must be retarded in thin castings so as to get the same rate as in thicker (heavier) castings. The means employed are:—To warm the mould before casting the metal to keep the mould hot immediately after the metal is cast, or to cast at a higher temperature. Every composition curve gives a definite cooling curve, the former curve being plotted in terms of carbon and silicon content and the latter in terms of wall-thicknesses and temperatures. From these curves one can see at once what cooling is necessary for a given charge and a given thickness of wall.

Of the means mentioned above, the preference should always be given to retarded cooling, as this prevents the hard outer skin forming, keeps down segregation and internal stresses, and allows the desired structure to develop gradually, with advantage to the mechanical properties of the material.

Heat Treatment Unnecessary.

This adaptation of composition to rate of cooling is definitely indispensable for the attainment of the pearlitic structure, and the Lanz method must undoubtedly be used when making thin-walled castings such as motor cylinders and the like.

The carbon content should be as low as possible in pearlitic cast iron, the most suitable percentages being such that the material, when cast normally, is white when cold.

The after-treatment of the mould, as recommended by the writer of the article criticised, is not necessary except as one of the arbitrary methods of regulating the rate of cooling.

Continuing his criticism, the writer states that a comparatively high sulphur content is not harmful where the Lanz process is adopted, but it certainly is not necessary in order to secure the desired result.

Another writer, Rudolf Stotz, has published an article in the journal "Industrieblatt," in which he states that his firm and others have been able to produce pearlitic cast iron very simply in the cupola furnace, by accurately controlling chemically the raw materials, the percentages of the constituents forming the charge, and the finished product. He stated that, as the result of practical experience, the carbon and silicon contents of cast iron should be very precisely adapted to the wall-thickness of the castings. Meyer, however, claims that this is merely the Lanz process again and that it cannot be evaded in this way.

Composition Considerations.

In his contribution to the discussion, A. Hammermann states that he has had remarkable results with the Lanz method, both from the standpoint of compactness and strength of the material produced. Pearlitic cast iron can be produced in any thickness of wall provided that the rate of cooling is properly adapted to the proportions of the constituent mixtures; but there are various reasons why cooling should be retarded as much as practicable, even when dealing with heavier castings, and this, of course, necessitates altering the constituents of the mixture and getting a rather hard metal. But the greatest advantage of the Lanz process, in this writer's view, is that pearlitic cast iron can be obtained with mixtures which, when cast at the normal rate of cooling, must be white. By that, he means mixtures having a low-carbon and silicon content. Emmel maintains that a manganese and silicon content of about 1 per cent. are necessary for the formation of the pearlitic structure, generally speaking. When it is remembered that an increase in carbon causes a decrease in the strength of the iron, the problem is to get machinable castings having a carbon content of about 3.2 per cent., and a silicon content of about 1 per cent. in wall thicknesses of, say, $\frac{3}{8}$ths in. In this case the normal rate of cooling does not answer, and it must be retarded.

Emmel seems to be of the opinion that a certain high percentage of sulphur is necessary for pearlitic cast iron. This is, however, untrue. The inventor of the process recommended a low sulphur content, but stated that a higher content was not deleterious. The cupola method of making pearlitic cast iron is in no way inferior to crucible furnace metal. Alternating impact tests can be carried out up to 100 blows upon the finished material produced in the cupola. The present writer also confirms Bauer's opinion of the excellent behaviour of the metal to sliding friction.

The Lanz process shows primarily that foundrymen must work in the direction of obtaining a certain structure, and it then indicates accurate rules according to which it is possible to get a purely pearlitic structure from one and the same charge, from the cupola, reverberatory and electric furnace, without difficulty, and without special arrangements or making special additions to the charge.

The Author's Relay.

Replying to the discussion on his Paper, K. EMMEL quotes the text of Lanz's patent,* in view of the fact that so much controversy is going on about "Lanz's Pearlitic Cast Iron." The text states: "Process for the manufacture of grey cast iron of high resistance to sliding stresses, characterised by a suitable composition of the charge and cooling adapted to the charge, whereby the structure of the finished casting is characterised mainly by lamellar pearlite, ferrite being excluded from it."

Hammermann states that it is the very nature of the Lanz process that the composition of the charge and the rate of cooling are relatively adapted so that pearlitic cast iron results. Since, however, the rate of cooling in a casting depends on its wall-thickness, and since the science or art of mixing charges has been from the very first to adapt the composition to the wall-thickness of the casting (or to the rate of cooling), and since the present writer states in his article that a pearlitic structure could be produced by properly selecting the charge, then Hammermann's statement of the nature of the Lanz process tallies with the present writer's (Emmel) view, that the pearlitic struc-

* Not necessarily similarly worded in British patent.—ED.

ture can be obtained in medium and heavy castings without using Lanz's process.

The idea of adapting the composition of the charge to the rate of cooling is not novel. The only original part about the Lanz process consists in artificially regulating the rate of cooling, although it certainly seems that Messrs. Lanz are justified in claiming that they alone have discovered how to select the charge according to a given wall thickness, and so to the rate of cooling because the thickness of wall itself affects the rate of cooling.

After replying to other minor criticisms, the author of the original Paper states that it would be a good thing if Messrs. Lanz would answer the following question regarding their process: "Do they claim to have evolved the process for the regulation of the rate of cooling by artificial means, or do they claim that they alone have evolved the method whereby the composition of the charge is brought into the proper proportion to the natural rate of cooling necessary for obtaining pearlite?"

Silica Brick of Constant Size.

In common with practically all known substances, silica bricks of ordinary construction expand under the influence of heat. Science has clearly defined and identified five successive inversions or changes in crystal structure in the process of an expanding silica brick, the final one of which is tridymite, at which point silica reaches its limit of expansion and the bonding strength of the interlocking crystals is then spent.

It has been pointed out by the United States Bureau of Standards that the bond in silica brick consists almost wholly in this interlocking cohesion of the various expanding crystal forms through which the brick passes in its gradual change from a green brick to the tridymitic condition. As this bond decreases in strength with the progress of expansion, which in extreme cases results in disintegration, the making of silica brick with an initial tridymitic condition requires a form of bond which will sustain the high temperature to which the brick is subjected, without becoming disintegrated.

A method of making brick having these characteristics has now been devised by Charles J. Crawford, New York, and the process has been patented.

Mr. Crawford's patent discloses a method of converting quartz or silica material to tridymite by means of a gaseous catalyser used in burning the product to expand it to tridymite, with specific gravity of 2.26 to 2.33. It is claimed that by this method no part of the catalyser (flux) becomes a part of the tridymite so made, and thus eliminates the addition of any flux, and even makes it possible to avoid the addition of lime, which is also a flux. The patent also discloses a method of weathering a high alumina flint clay and using this as a binder for the tridymite made by catalytic action. The product is made into brick and again burned, giving a silica brick consisting of tridymite bonded with a flint fire clay made of high alumina content.

By this method a brick of fixed volume is made; fixed volume, in that it neither expands nor contracts under a continued application of high heat, but remains the same size as it was when it was made. The fusion point of flint clay being considerably higher than that of quartz or silica material, and the absence of any fluxing material, as lime, etc., or a green brick bond, should add materially to the refractory value.

In manufacturing refractory shapes, their size is limited more or less by reason of the molecular movement which takes place under heat. In silica material it is expansion; in clay material it is contraction or shrinkage. It is claimed that this new process can be developed to such an extent that monolithic refractories structures can be made. Furnace roofs then will be made in sections which will span the roof.

The Bureau of Standards comment is that a tridymite brick would be a perfect silica brick but, inasmuch as its manufacture by the direct application of heat would require possibly fifty successive burnings, this makes it a commercial impossibility. Numerous experiments and attempts to convert silica to tridymite by the addition of fluxes have been made, but the fluxing material added became a component part of the silica brick and lowered the fusion point so much as greatly to impair its refractory value.—"Iron Age."

A Note on Files.

By J. E.

Comparatively few patternmakers of the present generation have used a rasp. Even a quarter of a century ago only those men who had originally been millwrights finished work with the rasp. Mechanics generally speak of rasps and files as though they were distinct tools, whereas the rasp is just a variety of the file. The teeth of a rasp are entirely separated from each other and are round on top, being formed by raising small portions of stock from the surface of the blank with a punch. Rasps are only used on soft material while "single cut" and "double cut" files are used for the harder metals. The modern patternmaker may use the rasp but seldom, although, with the development of metal patternmaking, single and double-cut files have become important tools.

The file is one of the simplest of tools and is also one of the most abused. A writer in a technical contemporary stated recently that he has been using the same file every day for nineteen years. This is surely a record, although careless usage shortens the lives of most files. The file mentioned was originally a dead smooth file, but it can now only be used in the lathe.

The value of a file depends upon the quality of the material used, the workmanship employed in shaping the teeth, and the temper; but the life, in addition to these, depends upon the use to which it is put and the care given. If all the teeth in a file were exactly the same height it would require a heavy pressure to make it cut, and it was formerly thought that machine-cut files would have that characteristic and for that reason would be inferior to a hand-cut file. Modern machines overcome this by giving files what is known as the increment cut in which there is a slight difference in the distance between the cuts; the difference is so slight that there is only about one-hundredth of an inch difference between the first and last cuts on a 12-in. file.

A useful kink to prevent cuttings from lodging between the teeth and scoring the work is to chalk the file thoroughly, although it prevents it from cutting so freely. It is also good practice, when a fine finish is wanted, to rub a new file very lightly with an oilstone. Where absolutely true surfaces are required a light stroke with a smooth file over a flat brass plate should be made. The high teeth can then be told by the brass adhering to them, and these teeth are cut with a drop of acid compound. After a little while the file is dipped in water to stop the action of the acid, and the process is then repeated.

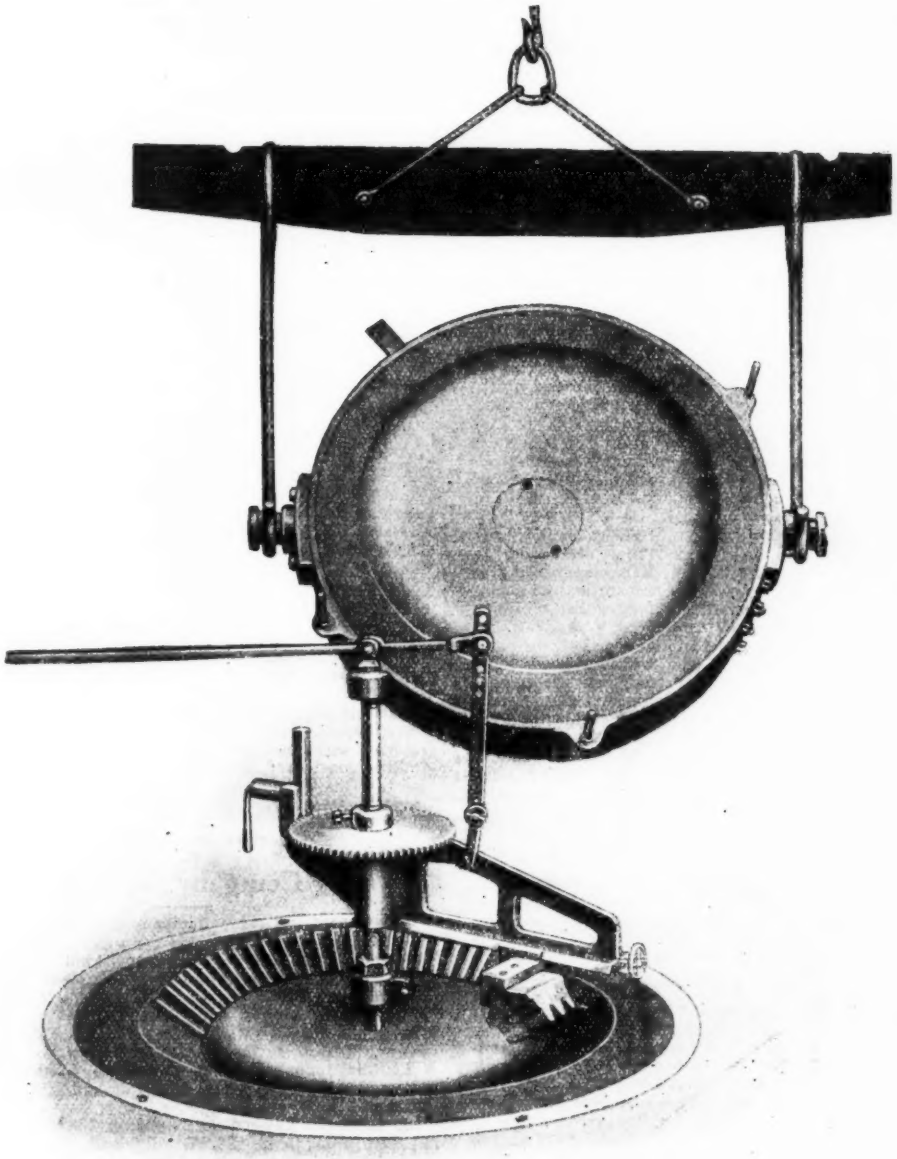
It is often overlooked that files are delicate edge tools and that they should not be thrown into a drawer with hammers and wrenches, but each file ought to be wrapped in cloth when not in use or they should be separated by wood partitions in a special tray.

The life of a file may be prolonged very simply. It is not always convenient to chalk the teeth and the ordinary wire file brush cannot remove all the small fragments of steel, iron, or non-ferrous metal which become firmly embedded between the teeth. Files are often scrapped because of this clogging between the teeth, when they are still quite sharp, instead of being renovated by emersing them for a few seconds in a solution of nitric acid of a specific gravity of 1.2. The files are dipped into a bath of the acid until the particles of metal between the teeth are loosened, when the files should be washed in running water, dipped in a bath of hot water, and then allowed to dry. The wire brush now cleans them thoroughly. Some care is necessary because, if the file is kept too long in the bath, the acid will attack the teeth.

A new file should never be used on very narrow work, as the teeth take too firm a hold and may be broken out, thus ruining the file. Narrow work should also be held as close to the vice jaws as possible to prevent chattering.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS,
(MANCHESTER), LIMITED,
BLACKFRIARS, MANCHESTER.

Trade Talk.

THE EBBW VALE STEELWORKS restarted on Monday.

THE RAIL MILL at the Barrow Steel Works closed down on Saturday, and it is not yet known when operations will be resumed.

THE WAGES regulated by the sliding scale under the Midland Iron and Steel Wages Board were advanced 2½ per cent. from Monday, August 4. The new rate will continue till Saturday, October 4.

THE UNDERFEED STOKER COMPANY, LIMITED, have recently taken orders for 38 travelling grates, five ash-conveyor plants, three air heaters, nine suspended arches, and 46 Underfeed stokers.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED, Falcon Works, Loughborough, have transferred their Cardiff office to 22, Dumfries Place, Cardiff.

A CONFIDENTIAL report on the market for wrought iron tubes and fittings in Chile has been prepared by the Department of Overseas Trade from information received from the Commercial Secretary at Santiago.

SEVERAL THOUSAND steel trade workers, representing the whole of the unskilled labour in the industry at three of the largest steel works on the outskirts of Sheffield, have decided to hand in, at the end of the week, a week's notice on the question of district rates and conditions.

THE MADRAS AND SOUTHERN MAHRATTA RAILWAY COMPANY have ordered 100 covered and 100 open goods wagons of broad gauge type from the Metropolitan Carriage and Wagon Company, Limited, of Birmingham.

ROBERTS & COOPER, LIMITED, Brierley Hill, Staffs, who recently closed their works, have decided to re-open their Bromley and Brettell Lane departments on the 18th inst., and the necessary preparations are being made. The works, comprising four mills, will find employment for about 200 men.

THE FIRST CONTRACT for the Lochaber hydro-electric scheme has been placed. The watersheds for more than 300 miles are to be harnessed, and the current generated at Fort William. Equipment to generate 100,000 horse power is to be installed. Aqueducts are to be driven through Ben Nevis for twenty miles.

IT HAS BEEN PROPOSED to provide Leeds with a memorial of Matthew Murray, the distinguished pioneer in machine engineering and in locomotive building, and the question is being submitted to the local branches of various engineering societies. The centenary of his death will be reached in February, 1926.

BRITISH REVERBERATORY FURNACES, LIMITED, of 82, Victoria Street, London, S.W.1, have recently sold non-ferrous melting plants of capacities varying from 5 cwts. to 2 tons to the following well-known firms:—Harland & Wolff, Limited, North Woolwich; Worthington Simpson, Limited, Newark; Sterling Metals, Limited, Coventry; London, Midland and Scottish Railway Company, Horwich and Derby Works; Allen Everitt & Sons, Limited, Birmingham; Burma Railways, Limited, Insein, Lower Burma, India; E. Austin & Sons, Limited, London; F. H. Adams, Limited, Birmingham; Mirrlees Watson Company, Limited, Glasgow; and Ward & Davidson, Limited, Sunderland.

THE OUTPUT from the Sunderland shipbuilding yards during the month of July was six vessels, with an aggregate gross tonnage of 22,145. This makes a total for the seven months of the present year of 39 vessels, and 131,523 gross tons, compared with eleven ships and 31,601 gross tons for the corresponding seven months of last year, and 17 vessels and 76,482 gross tons for the same period of 1922. The details of the past month's output are as follow:—W. Gray & Company, "City of Bedford," 6,554 gross tons; J. Crown & Sons, "Matching," 1,410 gross tons; Swan, Hunter, & Wigham Richardson, "James Dunford," 1,196 gross tons; Sunderland Shipbuilding Company, "Euphorbia," 3,385 gross tons; W. Doxford & Sons, "Vinemoor," 4,350 gross tons; Short Bros., "Kafiristan," 5,250 gross tons, total, 22,145 gross tons.

THE LEASEHOLD Birchgrove Structural Steelworks, Llansamlet, covering an area of about 11 acres, now in the occupation of the South Wales Structural Company, Limited, also the lease of the company's offices in Prudential Chambers, Swansea, and a warehouse at St. Thomas, Swansea, were offered for sale at Swansea last week. The works were offered as a going concern. It was explained that there were no outstanding contracts and that the name of the South Wales Structural Company did not go with the works. The property was eventually sold to Mr. J. O. Jones, Swansea, for £15,500.

Contracts Open.

Constantinople, September 1.—About 11 tons of red copper plates. The Department of Overseas Trade.

Wellington, N.Z., October 21.—Pumping plants, for Christchurch. The Department of Overseas Trade.

Montevideo, October 3.—Phosphor bronze wire for springs, special steel for tools in round bars, copper sheets, etc., for the State Electric Works, Montevideo. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Southborough, Kent, August 27.—Supply and laying 1,500 yards of 6-in. cast-iron water main, etc., for the U.D.C. G. & F. W. Hodson, Bank Chambers, Loughborough, and London. (Fee, £5 5s., returnable.)

Broadstairs, August 15.—Supply and erection of airless injection cold-starting crude oil engines, Mather & Platt turbine pumps, and other auxiliary plant, for the U.D.C. H. Rofe & Son, 208, Abbey House, Victoria Street, London, S.W.1. (Fee, £5 5s., returnable.)

Dublin, August 27.—Two 2-ton electrically-driven wharf cranes, for the Dublin Port and Docks Board. Mr. J. Mallagh, East Wall, Dublin.

London, S.W.1, October 3.—Supply and erection of one steam turbo-centrifugal pump, with condenser, piping and all accessories for the Rand Water Board. The Department of Overseas Trade, 35, Old Queen Street, London.

London, E.C., August 25.—Seven locomotive engines and tenders (4-6-0 standard superheated mixed type), "K" class, for the Burma Railways Company, Limited. Mr. F. C. Franks, secretary, 199, Gresham House, Old Broad Street, London, E.C.2. (Fee, £2, non-returnable.)

Newport, Mon., August 25.—10,000-kw. turbine, 10,000-kw. turbo-alternator, and surface-condensing plant, etc., for the Corporation. Mr. A. N. Moore, borough electrical and tramways engineer, Town Hall, Newport, Mon. (Fee, £3 3s., returnable.)

Sheffield, August 21.—Supply and erection of one sand dryer, with a capacity of two tons of dry sand per hour, for the Tramways, etc., Committee. Mr. A. R. Fearnley, general manager, Division Street, Sheffield.

Walsall, September 16.—Reconstruction of horizontal retort house, including installing bench of horizontal retorts, with the necessary coal-handling plant and stoking machinery, and Telpher coke-handling plant, for the Gas Committee. Mr. E. Davies, engineer and manager, Gasworks, Walsall. (Fee, £5 5s., returnable.)

Company News.

Chesterfield Tube Company, Limited.—Profit, £10,263; brought in, £7,485; carry forward, £11,316.

National Gas Engine Company, Limited.—Interim dividend, 2½ per cent. on preference; no ordinary interim.

Manchester Metals and Wire Company, Limited, 12, Queen Street, Manchester.—Capital £100 in £1 shares. Directors: R. Johnson and Mrs. L. Johnson.

Lentinal Industrial Locos. (England), Limited, 4, St. Mary Axe, London, E.C.3.—Capital £10,000 in £1 shares.

J. Grayson Lowood & Company, Limited.—Profit, £1,622; brought in, £2,253; dividend, 2½ per cent., making 5 per cent. for year, tax free; carry forward, £1,447.

A. Fell, Limited, Bridge Iron Works, Troutbeck Bridge, Windermere.—Capital £25,000 in £1 shares. Engineers and machinery manufacturers. Directors: S. H. Fell (managing) and E. C. Burnup.

Fletcher and Phillipson, Limited, 10, Lower Baggot Street, Dublin.—Capital £15,000 in £1 shares. Iron workers. Directors: B. A. Phillipson and R. B. Phillipson.

Henry Allan & Sons, Limited, 30-31, Clerkenwell Green, London, E.C.—Capital £6,000 in £1 shares. Iron founders, etc. Directors: H. B. Allan and H. Allan.

Personal.

SIR ALFRED STEVENS, proprietor of Stephens & Company, silica brick manufacturers, Kidwelly, is fighting the bye-election in the Conservative interest in the Carmarthen Division against Sir Alfred Mond. He is making a special point of the safeguarding of British industries, especially the steel trade, against unfair foreign competition, and is making great headway in the division.

Wills.

HUTCHISON, A., chairman of A. Hutchison & Son, Limited, of the London and Glasgow Ironfoundry, London, E. £16,727

YOU CAN TURN OUT
BETTER CASTINGS AT LESS COST
BY USING

Sterling

ROLLED STEEL
MOULDING BOXES

STERLING FOUNDRY SPECIALTIES, Ltd.
London Office:
13, VICTORIA ST., S.W.1. Sterling Works, BEDFORD.

SECTIONS OF STERLING ROLLED STEEL BAR AND STIFF SAND LEDGES SHOWING THE SOLID RIB

SECTIONS OF STERLING ROLLED STEEL BAR AND STIFF SAND LEDGES SHOWING THE SOLID RIB

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

Head Office: 23, ROYAL EXCHANGE SQUARE, GLASGOW.
Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.
CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.
Established 1872. *Telegraphic Address: "Steel, Glasgow."*

GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Very little actual business is now passing in the Cleveland iron market, conditions usually experienced in the holiday season, the home demand being on a limited scale, while the extent of export transactions of late may be estimated from a perusal of the appended return of July shipments, which only amounted to 32,524 tons, as against 37,795 tons in June, a decrease of 5,271 tons. The total in May was 64,212 tons. Of the July shipments only 20,161 tons went abroad and 12,363 tons coastwise, including 9,061 tons to Scotland. Belgium headed the list of foreign customers with 5,705 tons, as compared with 6,353 tons in June, Italy coming next with 3,491 tons, as against 5,180 tons. France took only 2,519 tons, as against 4,419 tons, and Germany 1,975 tons, as against 4,215 tons. Sweden, Norway and Denmark together took 3,165 tons. Prices meantime disclose few changes, the standard No. 3 G.M.B. quality having been done at 85s. per ton, and there are those who believe that the price will go even lower. No. 3 is down to 85s. per ton, No. 1 is about 90s., No. 4 foundry 84s., and No. 4 forge 83s. per ton.

Hematite continues a very slow market. Home inquiry is quiet, and the demand from abroad is at a very low ebb. Values are weak, East Coast mixed numbers offering at 93s. per ton, and it would appear questionable whether the price can long be maintained at its present level above foundry iron. No. 1 is at a premium of 6d. per ton. On the North-West Coast values are unchanged, Bessemer mixed numbers being quoted at 105s. per ton delivered at Glasgow, 110s. per ton delivered at Sheffield, and 115s. per ton delivered at Birmingham.

LANCASHIRE.—Demand for foundry iron from consumers in this area continues very poor, the outputs of the Midland furnaces far exceeding current requirements, with the probability of a curtailment of production in the near future. Buyers, however, seem to be fairly confident that prices in Manchester for No. 3 pig-iron will soon come down to 90s. per ton, but the current price here is still about 95s. to 96s. per ton. Northamptonshire No. 3 foundry iron is now quoted freely at 82s. 6d. per ton in trucks at the furnaces, but as the carriage is high, the delivered price in Manchester is about the same as that for the Derbyshire brands. Cleveland iron delivered here is still from 2s. to 2s. 6d. per ton above the cost of the Midland irons.

THE MIDLANDS.—A somewhat better report of business in this area is to hand, an increased business having been due to merchant buying, while several of the Northants and Derbyshire furnaces are said to have booked good sales for delivery ahead. It is now generally considered that quotations will not fall lower, as the present figures are quite unremunerative, and certain pig-iron makers declare that sooner than accept business at a lower basis they would blow out the furnaces. Current quotations are as follow:—Derbyshire No. 3 foundry, 85s. to 87s. 6d.; Staffordshire No. 3 foundry, 85s. to 87s. 6d.; Northants No. 3 foundry, 82s. 6d. to 83s. 6d.

SCOTLAND.—Conditions in the local foundry pig trade continue depressed, with prices easy at 93s. per ton for No. 3 Scotch at the furnaces, but there is no buying being done, and in consequence stocks are accumulating in spite of the curtailed output. One or two concerns are considering the question of buying some iron ahead, but no business is reported as having been done. No. 3 Middlesbrough has been sold at 90s. 6d. per ton f.o.t. Grahamston, but the light-castings founders are inclined to mark-time in the meantime until the air is cleared in regard to the impending dispute with the men.

Finished Iron.

Recent reports reveal nothing encouraging to say concerning finished iron, the interruption of work last week having been unusually complete, while order-books are exceptionally bare, so that the prospects for the immediate future are not at all encouraging. It is a remarkable thing that selling prices should be increasing under such very slack conditions, but it is part of the settled policy based on the argument that, as costs cannot be reduced to a competitive level which will bring business in large quantities, there is nothing to be gained by reducing selling prices. The advance in wages has stiffened manufacturers in this attitude. How hopeless it all is can be seen from the fact that Belgian No. 3 bars can be bought for £8 delivered at works, whereas the corresponding grade locally made are quoted at £12. The only branch at all satisfactory or profitable is marked bars.

Steel.

There have been no favourable developments in the steel industry since last reported, British producers of semi-products especially finding it very difficult indeed to make headway against current foreign competition. Sheffield makers of acid and basic billets require orders badly, but there are few buyers about. Basic qualities are, if anything, worse than acid. In the market for alloys, makers of ferro-manganese announce a further reduction of prices by £1, making the current home and export figures £15 per ton, either delivered or f.o.b.

Scrap.

No improvement can as yet be reported in the state of the scrap metal trade, which continues exceptionally quiet. In Lancashire, cast scrap is depressed by the further ease in foundry pig. Dealers claim that cast scrap at present prices is cheap, even if pig-iron gets down to 90s. in Manchester, but the ironfounder will, and does, expect a corresponding fall in the dealers' prices. At the moment dealers are fairly steady at 85s. per ton for good cast scrap, but one feels that the market is not in a good position. In Scotland, machinery cast-iron scrap is being offered at 95s. per ton, but sales are limited as the demand from the foundries is very poor. Ordinary cast-iron scrap in pieces not exceeding 1 cwt. is 87s. 6d. to 90s. per ton, but the demand is similar to machinery cast iron. Old cast-iron chairs changed hands last week at 93s. per ton, and light cast-iron scrap at 75s. per ton.

Metals.

Copper.—The position of standard copper, while generally firm, evidences only a limited increase in the actual business transacted, although the improved outlook in the European political situation may not unreasonably be accepted as a pointer to a better demand for the metal in the near future. The appreciation of sterling in the States may be expected also to facilitate purchases on home account on this side, and may explain in some measure recent speculative operations in the market, but so far the advance in values has been on a comparatively moderate scale. Current quotations:—*Cash*: Thursday, £63 17s. 6d.; Friday, £63 12s. 6d.; Monday, £63 17s. 6d.; Tuesday, £63 12s. 6d.; Wednesday, £63 12s. 6d. *Three Months*: Thursday, £64 17s. 6d.; Friday, £64 10s.; Monday, £64 17s. 6d.; Tuesday, £64 12s. 6d.; Wednesday, £64 12s. 6d.

Tin.—Based on the fairly satisfactory statistical position disclosed below, the market for standard tin has maintained its previous buoyancy, and values are mostly maintained at the high levels recently reached. In America, some fairly heavy buying has taken place, the improved conditions there contributing very largely to the firmness of the London market. At to-day's price tin can no longer be considered cheap, and some fresh impetus will be required if much further advance is to take place.

Ricard & Freiwald's statistics of tin for July are appended:—

STOCKS, LANDING AND AFLOAT, EUROPE AND AMERICA.—United Kingdom: Stocks in London, 1,437 tons; stocks in other ports, 2,433 tons; total, 3,870 tons; landing and in transit, 125 tons; afloat from Straits, 2,845 tons; afloat from Australia, 125 tons; total United Kingdom, 6,965 tons. Holland: Banca spot, 991 tons; Banca and/or Billiton afloat to Europe and America, 1,202 tons. Continent: Straits afloat, 1,155 tons. United States: Spot and landing, 5,059 tons; afloat, 4,090 tons; total visible supply, 19,462 tons.

Current quotations:—*Cash*: Thursday, £256; Friday, £255; Monday, £253 15s.; Tuesday, £250 15s.; Wednesday, £249 15s. *Three Months*: Thursday, £256 5s.; Friday, £255 5s.; Monday, £254 5s.; Tuesday, £251 10s.; Wednesday, £250 10s.

Spelter.—The market for this metal discloses an easier tendency. Rudolf Wolff & Company report that the higher prices had attracted some selling both for American and Continental account, and once values began to recede a certain amount of realisation took place, buyers at the same time showing more reserve in face of the slack demand on the part of consumers. Current quotations:—*Ordinary*: Thursday, £32 7s. 6d.; Friday, £31 17s. 6d.; Monday, £31 12s. 6d.; Tuesday, £31 17s. 6d.; Wednesday, £31 17s. 6d.

Lead.—The market for soft foreign pig continues fairly active, with prices a shade below quotations for last week. Easier conditions now prevail, buyers showing more reserve, and sellers coming out more freely on all sides for all deliveries. Current quotations:—*Soft foreign (prompt)*: Thursday, £32 3s. 9d.; Friday, £31 17s. 6d.; Monday, £32; Tuesday, £32 12s. 6d.; Wednesday, £33.